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BRIEFLY TOLD.

DEATH OF MR. HENRY B. LEACH.—Again we are called upon to chronicle the death of a member of the gas fraternity, whose record in its history is that of work well and worthily performed. Mr. Henry B. Leach, who had been in the employ of the Taunton (Mass.) Gas Light Company for a third of a century or more, died the afternoon of Saturday, the 25th ult., under peculiarly shocking circumstances. At noon of that day he attended a session in Boston of the Guild of Gas Managers (of which representative association of Eastern gas men he was a founding member), and after adjournment was taken, with the purpose of journeying to Nahant, where a beach dinner was to be enjoyed, at the invitation of Mr. C. F. Prichard, of Lynn, while on the boat and in animated conversation with friends, Mr. Leach put his hand to his head, reeled and fell. He had been stricken with appoplexy, and his death was instantaneous. The body was removed to the Relief Hospital in Boston, where it was shown that death had done its fatal work. The funeral services were held in his late home, 68 Washington street. Taunton, the afternoon of the 28th ult., the Rev. George Hale Reed, of Belmont, officiating. The mourners numbered many members of the Guild of Gas Managers, the New England Association of Gas Engineers, the Society of Gas Lighting and the American Gas Light Association, in all of which bodies he was a well-known and well-liked member. The floral tributes included beautiful offerings from the Guild of Gas Managers and the New England Association of Gas Engineers. He is survived by his widow, a daughter, and a brother, who is a resident of this city. Blunt, hale, hearty mannered man that he was, his ways were those that endear one to his fellow men. In due time we will print an accurate account of his long and fruitful career in the industry that claimed all of his active business life.

NOTES——

THE annual meeting of the Managers and Superintendents of the Railways and Light Company, of America, will be held at Ocean View, near Norfolk, Va., the 4th, 5th and 6th insts. The paper list contains among its numbers the following: "High Pressure Distribution of Gas," by Mr. H. L. Rice, General Manager, City Gas Company, of Norfolk. "Advantages of Direct Current Inclosed Arc Lamps over Alternating Current Lamps of Same Voltage," by Mr. T. Fitzgerald, Lexington, Ky. "Advantages of Meter over Flat Rates," by Mr. H. R. Palmer, Norfolk, Va. "Educating the Consumer," by Mr. R. J. Marks, Superintendent, Lexington (Ky.) Gas Company. A feature of the entertainment part of the sessions will be a banquet, set for Thursday evening.

MESSRS. LINDSAY & CO., of Chicago, have opened a branch distributing office in St. Louis, with headquarters at 1113 Pine street. The branch will be under charge of Mr. W. W. Martin, formerly Manager of the Welsbach Company's St. Paul-Minneapolis branch. It is proposed to carry a full stock of the Company's specialties—incandescent mantles, burners, etc.—for the better supply of such goods to the trade west of the Mississippi and in the Northwest. The Company's new catalogue and price sheets will be ready by the 15th inst.

LIBRARY OF CONGRESS. AUG 3 1903 SMITHSONIAN DEPOSIT.

MR. C. T. BECKWITH, Secretary of the Oberlin (O.) Gas Company, has certified to an increase in its capital stock, from $30,000 to $75,000.

THE report of the Detroit City Gas Company, for the 6 months ended June 30th, shows that the output in that period amounted to 275,620,000 cubic feet, as against 260,790,000 cubic feet for the corresponding half of 1902.

AT the annual meeting of the Greenfield (Mass.) Gas Company no change was made in the executive management. A dividend of 3 per cent. for the half year was declared.

THE Philadelphia *Ledger*, of the 26th ult., says that the sum of $159,658.35, according to the quarterly report of the United Gas Improvement Company, rendered to the City Controller yesterday, will be turned into the City Treasury, and represents the percentage due the city for gas furnished consumers under the lease held by the Company. The report shows that during the quarter ending June 30 the Company sold 1,448,556,250 feet of gas, and the receipts for the same period, with old bills collected for previous quarters, for 1,596,583,470 cubic feet of gas furnished consumers, amounted to $1,596,585.47. The total sum paid into the City Treasury by the United Gas Improvement Company under the percentage clause of the lease since assuming control of the gas works amounts to $700,622.36."

AT the annual meeting of the Easthampton (Mass.) Gas Company, the officers elected were: Directors, H. L. Clark, George L. Manchester and C. H. Johnson; President, H. L. Clark; Treasurer and Manager, George L Manchester; Clerk, Philip Mayher. A semi-annual dividend of 3 per cent. was declared.

A CORRESPONDENT forwards the following from Boston, Mass., under date of the 25th ult.: A pleasant episode took place in the office of the State Board of Gas and Electric Light Commissioners yesterday in honor of Commissioner Gifford, who retires from office August 1st. An expressman delivered a suspicious looking box at the department, and Commissioner Barker laid it on Mr. Gifford's desk, at the same time stating that it contained something from the whole office force which was intended as a slight token of their esteem. While completely surprised, Commissioner Gifford expressed his thanks for the remembrance and for the spirit which prompted it. In the box was a silver loving cup on an ebony standard, the whole being about 10 inches in height. The cup is inscribed as follows:

To
Charles H. Gifford
of
New Bedford,
Always kind, always courteous, always just,
from
his associates in the office.
1894-1903.

THE selling rate for natural gas in Columbus, O., has been advanced from 20 cents to 25 cents per 1,000 cubic feet, the increase to go into effect October 1st.

THE Kerr Murray Manufacturing Company, of Fort Wayne, Ind., is erecting a storage holder of 110,000 cubic feet capacity for the Lafayette (Ind.) Gas Company.

MR. L. A. MORRISS has been appointed Superintendent of the gas and electric plants of the Bay City (Mich.) Gas Company.

MESSRS. E. M. DEANE & COMPANY, of Detroit, Mich., have completed arrangements for the taking over of the gas, electric light and street railway plants of Alpena, Mich. The succeeding corporation will be known as the Alpena Gas Light, Fuel and Power Company.

A CORRESPONDENT in Chicago forwards the following: "A $5,000 damage suit, based on the alleged injury done to her eyes by having the gas in her home shut off, and the loss of two boarders, has been filed in the Superior Court, against the Peoples Gas Light and Coke Company, by Carrie Gorman. The plaintiff alleges that on July 31, 1901, she lived at 2226 Wabash avenue and was employed as a seamstress. On that date she asserts that the defendant cut off her supply of gas, although she had paid her gas bills. As a result she was obliged to use an oil lamp, which caused great injury to her eyes. Two boarders, she alleges, left her because she could furnish them only with an oil lamp. She declares that she was also obliged to have the uncleanliness of oil about the place and was caused great inconvenience and discomfort. Her reputation and credit, she also alleges, were injured."

Loss of Illuminating Power of Mantles while Burning.[1]

[A paper prepared by Messrs. ALFRED H. WHITE and M. E. MUELLER, for the meeting of the Michigan Gas Association, held in Battle Creek, Mich., Feb. 18-19.]

The papers that have been read at your previous meetings,[2] giving results of investigations carried on in the Chemical Laboratory of the University of Michigan, have dealt with conditions under which the incandescent gas mantle gives its best results and the effect of temperature on illumination. For this year we have chosen to study the causes of the deterioration of mantles while burning.

We have not considered the effects of shock or vibration of any sort which by mechanical action break the mantle, but have endeavored to find some reason for the slow drop in illumination and efficiency which takes place during the life of the mantle. Some change must occur, either in its micro structure or chemical composition, and it has been the nature of this change which we have been studying.

The deterioration of the mantle has been commonly believed to be progressive and regular, but photometric tests have almost universally revealed marked fluctuations in the light given by a mantle. So much is this the case that some upholders of the catalytic theory, and notably some German mantle manufacturers, have claimed that the illumination given by a mantle varies rhythmically or periodically, and that by proper manipulation in manufacture some mantles may be made even to increase in illumination while they burn. In order to test whether this variation is periodic or not, a mantle from a well known German manufacturer, who claimed this property for his mantles, was tested side by side with a standard American mantle. The burner used in each case was a Welsbach, No. 60, with 8-inch cylindrical glass chimney, and the gas pressure was kept constant during the tests at 2 inches. Tests were made every 24 hours, the burner being set by repeated adjustment until it gave its maximum illumination in the direction measured. Record was kept of meter temperature, moisture in air of photometer room, barometric pressure, heating value of gas, and all other data which it was thought could be of service in interpreting the results. Table I. gives the results and Plate I. shows graphically the relations

TABLE I.—*Data of Daily Tests of Two Mantles.*

Days Burned.	Net Heat. Value of Gas. B.T.U. Per Cu. Ft.	Atmos. Moisture Gr. Per Cu. Ft.	Barometer, mm.	Exp. 53—American Mantle.				Exp. 54—German Mantle.			
				Consump. Corr. to 60° F. and 760 mm.	Total Candles.	Candles Per Cu. Ft.	B.T.U. Per Candle Hour.	Consump. Corr. to 60° F. and 760 mm.	Total Candles	Candles Per Cu Ft	B.T.U. Per Candle Hour.
0	580	5.0	743	3.45	73.8	21.1	27.5	4.50	64.6	14.3	40.6
1	571	5.6	744	3.36	70.6	21.0	27.1	4.15	67.3	16.2	35.3
2	584	5.7	742	3.54	66.8	18.8	31.0	4.15	73.4	17.7	32.9
3	576	5.5	735	3.60	66.2	18.3	31.4	4.17	72.2	17.3	33.2
4	581	3.6	744	3.32	66.6	20.0	29.0	4.03	73.1	18.1	32.1
5	570	3.2	744	3.34	66.9	20.0	28.5	4.19	73.4	17.5	32.6
6	605	3.5	734	3.25	67.8	20.8	29.1	3.84	75.7	19.7	30.6
7	578	3.3	737	3.49	63.7	18.2	31.7	4.19	69.9	16.6	34.8
8	576	3.1	745	3.62	65.4	18.0	32.0	4.02	71.6	17.8	32.4
9	590	3.2	744	3.45	67.5	19.5	30.2	3.99	72.7	18.2	32 4
10	590	3.7	742	3.36	62.5	18.6	31.7	4.13	70.5	17.0	34.7
11	581	3.3	747	3.56	63.2	17.7	32.8	4.24	69.1	16.3	35.7
12	578	2.8	751	3.48	63.9	18.3	31.6	3.90	64.6	16.5	35.0
13	585	2.9	737	3.67	69.5	18.9	30.9	3.90	70.6	18.0	32.5
14	593	3.4	736	3.43	63.9	18.6	32.8	3.91	68.5	17.5	33.9
15	604	4.7	740	3.67	68.5	18.7	32.3	3.62	68.5	18.9	32.0
16	589	5.8	726	3.43	60.6	17.6	33.4	4.12	63.2	15.3	38.5

existing between the two mantles; experiment 53 referring to the American and 54 to the German mantle. By reference to this plate it will be seen that there are very marked and irregular fluctuations of candle power in both cases, and that after the first 48 hours the curves are in general parallel. The same irregularity and rough parallelism are observed in the curves showing candles per cubic foot. The change in illumination is evidently a function of some variable outside of the mantle, for the chances that two mantles of entirely different makes

1 Mr. White, Director of Chemical Technology, Chem. Lab., University of Mich., in forwarding us this paper for publication, says: "This paper, although read at the meeting, was withheld from publication, because some of the experiments were not completed and has just been printed for distribution to members of the Association."

2. "Relation of Heating to Lighting Power of Gases, with Special Relation to Incandescent Mantles." A. H. White and H. Russell, AMERICAN GAS LIGHT JOURNAL, 74, 468 (1901).
"Theory of the Incandescent Gas Mantle." A. H. White, A. F. Traver and H. Russell. AMERICAN GAS LIGHT JOURNAL, 76, 143 (1902).
"Theory of the Incandescent Gas Mantle." Second paper. A. H. White and A. F. Traver. *Jour. Soc. Chem. Ind.*, 1902, 1012.

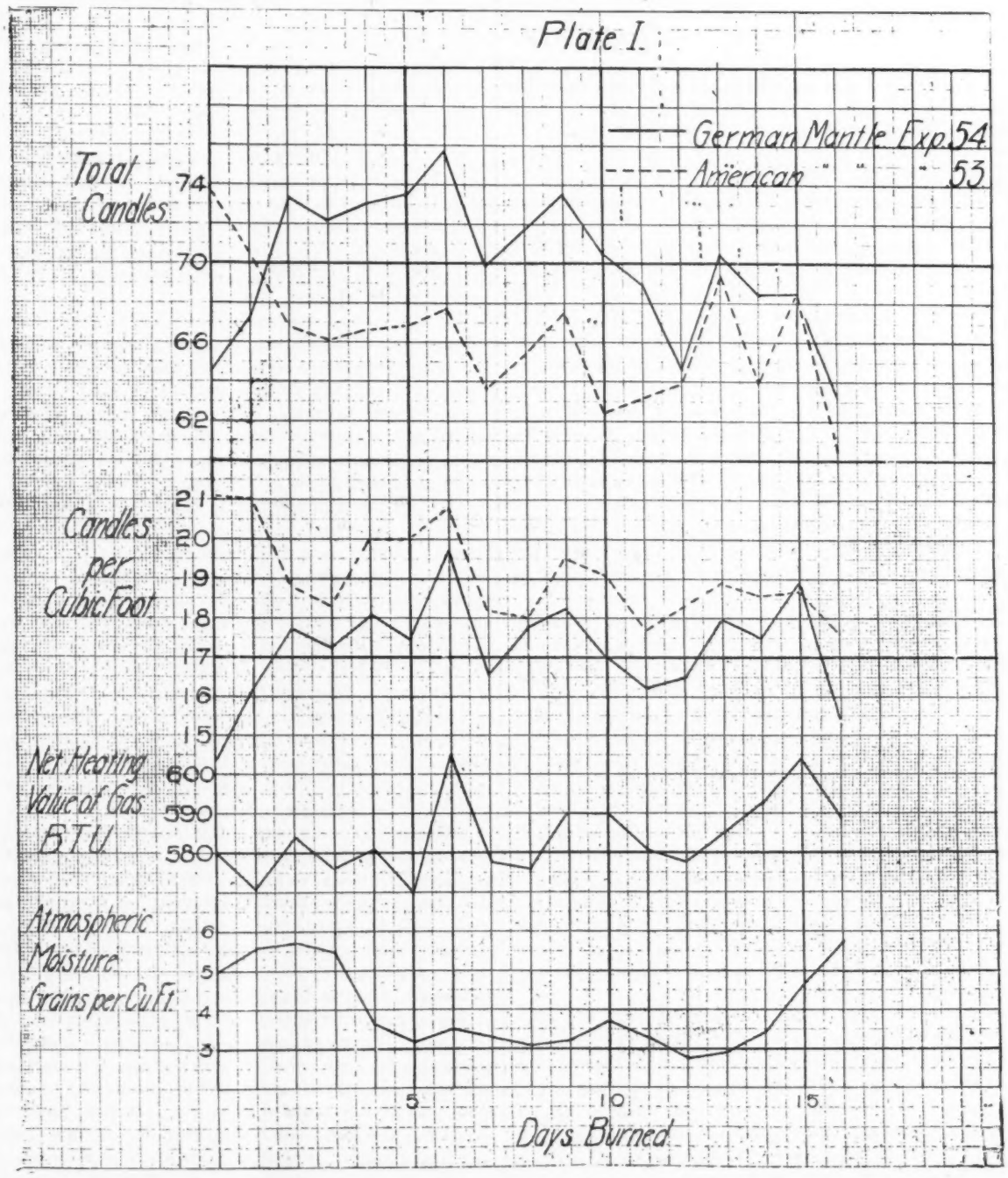

Plate I.—Relation of Heating Value of Gas and Atmospheric Moisture to Illumination and Efficiency of Two Mantles.

should have the same apparently irregular period is a very slight one. The curve showing the net heating value of the gas indicates a factor which has influenced the result to a marked extent. The parallelism between the curves showing candles per cubic foot and net heating value is striking. It is not quantitative; but when the errors involved in setting the mantles at their highest illumination and in measuring their candle power are taken into account, the agreement is so good that a close connection must be granted between the heating value of the gas and the illumination. This connection is merely an indirect one, due to the influence of changes in the composition of the gas upon the volume and temperature of the products of combustion, but this change is more correctly indicated by change in the net heating value than by any one other easily observed factor.

Another influence which undoubtedly affects the lighting value of the mantle is moisture in the air, the extent of which influence has, so far as we know, never been studied. We used as our photometric standard a 10-candle pentane lamp, which is known to be affected by moisture in the air, and it became important to obtain some indication of its relative effect on the mantle and the pentane standard. With this end in view, the moisture of the photometer room was artificially changed by hanging wet cloths near the ventilating inlets and moistening the floor and walls of the room, and a number of readings were made while the air became saturated with moisture and also as the room dried again. The adjustment of the mantle was not changed during the experiment, and the pentane lamp was kept burning at the proper height. Determinations of moisture were made simultaneously with the photometric readings. No determinations of the carbon dioxide in the air were made, but its amount was kept constant as far as possible by not taking the photometric readings until after the observers had remained in the room long enough to allow the conditions to become uniform. After the first test the walls were moistened and the consequent changes in illumination observed. With the mantle tested an increase of moisture was found to affect the mantle more than the pentane standard, so that while its candle power with 3 grains of moisture to the cubic foot was 62.0, at 6 grainsit had dropped to 60.4, a decrease of .53 candles per grain increase in moisture. A second series showed a drop of .46 candles for each grain increase, the points being on a straight line. This variation is not determined with sufficient accuracy to be applied quantitatively, but it shows that the influence of moisture is a measurable one, working more to the disadvantage of the mantle than of the pentane standard. The influence of change in barometric pressure has not been investigated.

When examining the curves of Plate I. in detail, the marked changes in candle power during the first 2 days are most striking. We have found such changes in the first few days' life of almost all mantles examined, and believe them to be due to the mantle shrinking and shaping itself to the flame. We have found no uniformity in the direction of this change, even among mantles of the same make, and no im-

portance is to be attached to the fact that in this particular instance one of the mantles increases and the other decreases in its illumination during the first 2 days. The deduction of general application to be drawn from this is that mantles which are to be tested for efficiency should be allowed to burn at least 48 hours in order that they may have settled to a somewhat permanent state. It will be noted that the position of the 2 mantles is reversed in the "illumination" and "efficiency" curves, the German mantle showing a higher candle power; but, on account of its looser texture, consuming more gas and giving a lower efficiency than the American mantle. After the second day we find a general agreement in the fluctuations of the 2 mantles, which is best studied in the "candles per cubic foot" curve. An experimental error of half a candle per cubic foot cannot be considered exorbitant in this work, which involves setting for maximum illumination, and such a change made in the value of either mantle would be sufficient to bring about almost exact parallelism, except on the eighth day, where there has probably been an error in reporting the consumption of the German mantle. In trying to account for the variations in the candles per cubic foot curve we shall take into account the heating value of the gas and the atmospheric moisture. The gas used was from the city mains. The wide variations in its heating value from day to day were due to the coal famine, which compelled the gas company to use widely varying amounts of carburetted water gas. These fluctuations make the work of adjustment more difficult, but on the other hand also bring out the effects of such variations in the gas on its lighting value.

Referring to the "candles per cubic foot" curve of Plate I., and passover the first 2 days' tests for reasons previously mentioned, we find, from the 3rd to the 10th day, that the efficiency varies with the heating value in a fairly uniform manner. An exception is to be made in the case of the 8th day, where there is undoubtedly an experimental error. The influence of the drop in atmospheric moisture on the 4th day is shown by the relatively large increase in efficiency as compared with the change of heating value. On the 10th day there is a falling off in efficiency of both mantles, while the heating value remains unchanged. The increase of moisture on this day will partially but not completely account for this. Similarly, on the the 12th day the low moisture and the extraordinarily high barometric pressure account for at least part of the disagreement between the change in heating value of the gas and the efficiency of the mantles. On the 14th day there is a disagreement for which we are unable to account. On the 16th day a small vertical crack, which had been present on the German mantle since the 6th day, increased so that the test was stopped.

These experiments give no support whatever to the "periodic" theory of the change in the mantle's illumination. The factor which has exerted the most influence on the mantle's illumination and efficiency has been the heating value of the gas, with the amount of moisture in the atmosphere ranking next in importance. These tests confirm the conclusions announced in previous papers that, within the limits of composition of the gas for which a given burner is adapted, the efficiency of a given mantle will be chiefly a function of the heating value of the gas.

These mantles in their test of only 16 days had not shown any marked diminution in their efficiency. If we compare the candles per cubic foot at the end of the 2d and 13th days, the heating value being the same, we find little change in the figures. Nevertheless, there is no doubt that mantles do almost universally deteriorate, and we have confirmed this by the life history of many mantles. Since the change cannot be ascribed to any periodic change in the mantle, the reason must be sought in some alteration in its physical structure or chemical composition.

The changes in the mantle shown by the microscope have been studied with care by others, notably by Dr. Killing,[1] who has shown that the fine threads of oxides sinter together and shrink by long exposure to the flame. We have followed with photomicrographs the changes taking place in several mantles during their life. Some showed marked shrinkage, but in others we were scarcely able to find a change after 900 hours' burning, and we could not believe that this slight change was sufficient to account for the large decrease in illumination observed in these mantles. There remained as a totally new field of experiment the changes taking place in the chemical composition of the mantle during its life. Such changes might be brought about by the deposition of a foreign substance on the mantle from the air or gas, or they might be caused by the removal of part of the material originally composing the mantle.

The deposition on the mantle of iron oxide from iron carbonyl in the gas has been studied by others. Its presence is easily detected by the brown coating of ferric oxide on the mantle. We have noted its effects in only one case. When working with unpurified blue water gas its harmful influence was shown in a very few minutes, by the drop in illumination and the appearance of a brown coating on the mantle. Iron carbonyl is not normally present in gas, and since deterioration due to it is so readily recognized we have not studied its effects further.

1. *J fuer Gasbeleuchtung*, 1902, 461.

A study in the change in the chemical composition of the mantle required a delicate method for the estimation of cerium in the mantle oxides which could be applied to samples of less than 100 milligrams. The method finally adopted is based on that of E. Benz,[1] and is a calorimetric one involving the oxidation of the cerium salts by hydrogen peroxide in faintly ammoniacal citrate solution. The details of the method are as follows:

For a standard we used a solution of mixed cerium and thorium nitrates, containing the equivalent of .0000344g CeO_2 and .0034g ThO_2 per cc. This corresponds very closely to a N/5,000 cerium solution. The mantle or part thereof to be analyzed is fused with 10 times its weight of sodium acid sulphate. The sodium is used in preference to the potassium salt to avoid the formation of the difficultly soluble double sulphates of thorium and potassium. After fusion the mass is dissolved in cold water, transferred to a 100 cc. graduated flask and diluted to the mark, An aliquot part of this, depending on the weight and cerium content of the sample, is run into a Nessler tube and used for the calorimetric comparison. The comparison is most delicate when about .00015 — .0002 grams of CeO_2 are at present in the solution. Nessler tubes, about an inch in diameter, answer well. To another similar tube is added a 10 per cent. solution of sodium acid sulphate corresponding in sulphate to the amount present in the solution to be tested. About 2.5 cc. of a 25 per cent. solution of potassium citrate and 10 to 15 drops of a 3 per cent. hydrogen peroxide solution are then added to both tubes and the liquid brought to the same height. The volume should not be less than 50 cc. Dilute ammonia is now added, drop by drop, until the solutions are faintly ammoniacal to litmus paper. The solution containing the mantle will be colored yellow, due to the oxidation of the cerium, while the other will remain colorless. Care must be taken not to add too much ammonia or the thorium will precipitate out notwithstanding the presence of the citrate. The tubes are then set into black cardboard cylinders, so that all light is transmitted through the bottom. The standard cerium-thorium solution is now run into the standard tube from a burette, a few drops at a time, until, on looking down the tubes against a white surface, the color appears the same. The standard tube must be shaken well after each addition. After the colors have been matched it is best to destroy the color in both tubes by acidifying with sulphuric acid, whereupon the cerium is reduced and the solution decolorized. The solutions are then once more oxidized by adding a few drops of hydrogen peroxide and making ammoniacal. Upon again comparing the colors it is sometimes found that not enough cerium has been run into the standard tube. In this case the solutions are again brought to the same color, and from the volume of standard solution used the amount of cerium in the unknown solution is calculated. The thorium present makes the color lighter, but it has been found that when it is present in 10 times the amount of the cerium additional thorium has no further effect on the color. The standard solution used, containing thorium and cerium in the ratio of 100 to 1, will, therefore, answer for analyses of samples showing under 10 per cent. of cerium. We have found it better to use a single solution of thorium and cerium than to add to the standard tube the proper amount of thorium, oxidize, make ammoniacal, and then add cerium to the proper color. In the latter case it has been found that a considerable addition of cerium is almost always necessary in order to bring the color in the standard up to that of the unknown after decolorizing and reoxidizing the solutions. The presence of iron interferes with this estimation of cerium, as it also produces a yellow color, due to the formation of ferric salts. The minimum amount of iron which was found to have an appreciable effect on the color is about .00004g. Several mantles were tested for iron after long periods of burning, but no determinable amount was ever found except in the case of the mantle above mentioned, which was tested on unpurified blue water gas. The method is a delicate one, and it is possible to detect the difference in color of two solutions, due to 0.01 — 0.02 milligrams of ceria. As an illustration of the accuracy to be expected in regular work, the results of 8 analyses of mantles of known percentage of cerium are given:

Per Cent. CeO_2 Present.	Found by Analysis.	
.50	.50	.51
1.00	1.05	1.01
2.00	2.15	2.05
3.00	3.09	2.94

1. *Zeit. Anal. Chem.*, 1902, 297.

Analyses of mantles which had burned a long time showed that the percentage of cerium was less than in new mantles of similar brand, and that the cerium was no longer uniformly distributed throughout the mantle. In preparing an old mantle for analysis, the top ½ inch was rejected as probably containing foreign ingredients added to give it strength. The remainder was cut into 4 portions. The part which was clearly below the level of the burner cap was cut off and marked "bottom." Next a narrow band about ½ inch wide, which included the doubtful portion just at the level of the cap, was rejected, and then the rest of the mantle was cut into two portions marked "middle" and "top." The middle section represented the part of the mantle most highly heated, the top had not been subjected to such a high temperature, and the bottom, which had not been heated at all, represented the original composition of the mantle. This latter point was proved by the analysis of the bottoms of mantles of known initial cerium content after they had burned for long periods. Analyses of old mantles uniformly showed a lower percentage of cerium in the middle than in the top, and a lower percentage in the top than in the bottom.

As a typical case we may cite a mantle of a well recognized make which gave, when tested after 48 hours, 64 candles, or 16.6 candles per cubic foot. Tests made every 2 or 3 days showed a gradual diminution in illumination. After 29 days, when the heating value of the gas was almost the same as before, its candle power had sunk to 47.8 candles and its efficiency to 13.3. It was still in good condition after the test on the 45th day, but a chimney breaking 2 days later spoiled it. The last photometric test made on a better gas than those mentioned showed 44.0 candles and an efficiency of 12.9 candles per cubic foot. The analysis of this mantle after it had burned 1,150 hours showed that the bottom contained .64 per cent. of cerium oxide, the middle .23 per cent. and the top .28 per cent. The drop in illumination from 64 to 44 candles had been accompanied by a drop of from .64 to .23 per cent. in the cerium content of the highly heated zone of the mantle.

That this decrease in the percentage of cerium is due to a real loss and not to an increase of some other constituent taken up from the gas was shown in two ways. First, a mantle was carefully weighed and started burning, and again weighed at the end of 1, 2, 4, 6 and 8 days, when it broke. It lost weight steadily, and at the rate of approximately one milligram a day during that time. Second, the deposits with which the insides of the glass chimneys became coated were washed off and collected for analysis. A sample of 84 milligrams collected in this way contained 93 per cent. of sodium sulphate. In another sample of the deposit collected from several chimneys the mixed thorium and cerium compounds were precipitated as oxalates, filtered, ignited to the oxides and the cerium determined colorimetrically. This was found to be 26 per cent. of the combined oxides. Whereas, in the mantle the ratio of thorium to cerium oxide is about 100 to 1, in the chimney deposit it is 3 to 1, showing conclusively that the cerium volatilizes more rapidly than the thorium. Another sample of chimney deposit examined in the same way showed 12 per cent. oxide of cerium.

It has been shown by experiments on many different mantles that the decrease in illumination is always accompanied by a decrease in its percentage of cerium. The variations in physical properties and method of manufacture of mantles from different makers render it impossible to draw any conclusions as to the quantitative relation between the decrease in cerium and the fall in illumination. In order that we might test this point, the Welsbach Company kindly manufactured for us a set of mantles which were alike except in the percentage of ceria. One lot of mantles were pure thoria, and the other contained 0.5, 1, 2 and 3 per cent of ceria, respectively. Tests were made on these mantles burning side by side, two separate series being made for 900 hours. When the tests were stopped the mantles were analyzed. The data are given complete in Tables II. to V., and the photometric results of one series are shown graphically in Plate II. In both series the candle power decreases rapidly with the .5 per cent. ceria mantle, less rapidly but still markedly with the 1 per cent., decreases slightly with the 2 per cent. and increases with the 3 per cent. mantle. The candles per cubic foot change in the same way. The marked difference in the heating value of the gas in the two series makes direct comparison difficult, but this may be partially eliminated by calculating the illumination as a function of the heating value alone, and plotting British thermal units per candle hour. In this method of plotting a rise in the curve means a decrease in efficiency. This is also shown in Plate II. The more rapid deterioration of the mantles with the low cerium content and the actual improvement of those with the high percentage of cerium are now evident.

In the analysis of these mantles the top, middle and bottom were analyzed separately, as before explained. The results are given below. In the 900 hours burning, the cerium in the hot zone had dropped to from 40-60 per cent. of what it initially contained.

Mantle.	Exp. Number.	Percentage of Ceria. Bottom.	Middle.	Top.
.5 per cent	58	.51	.21	.39
.5 "	63	.50	.32	.42
1.0 "	59	1.05	.43	.79
1.0 "	64	1.01	.37	.72
2.0 "	60	2.05	.71	1.37
2.0 "	65	2.15	.88	1.50
3.0 "	61	2.94	1.56	2.66
3.0 "	66	3.09	1.51	2.40

The relation between the final cerium content in the middle of the mantle and the illumination is best expressed graphically by plotting the cerium content and the B. T. U. per candle hour of the last test. The curve is shown in Plate III. It is approximately a parabola with

TABLE II.—*Exp.* 58 *and* 59.

Hours Burned.	Net Heat. Value of Gas. B.T.U. Per Cu. Ft.	Exp. 58—0.5 Per Cent. Ce O_2 Mantle. Consump. Corr. to 60° F. 760 mm. Cu. Ft.	Total Candles.	Candles Per Cu. Ft.	B.T.U. Per Candle Hour.	Exp. 59.—1 Per Cent. Ce O_2 Mantle. Consump. Corr. to 60° F. 760 mm. Cu. Ft.	Total Candles.	Candles Per Cu. Ft.	B.T.U. Per Candle Hour.
0	595	3.29	56.9	17.3	34.4	3.27	54.6	16.7	35.6
24	585	3.33	52.1	15.6	37.4	3.14	51.6	16.4	35.6
100	586	3.34	47.6	14.3	41.1	2.96	46.0	15.5	37.7
300	593	3.34	37.1	11.1	53.4	2.64	37.1	14.1	42.2
600	594	3.28	33.0	10.1	59.0	2.85	36.8	12.9	46.0
900	603	3.11	29.1	9.4	64.4	2.72	34.1	12.5	48.1

TABLE III.

Hours Burned.	Net Heat. Value Gas. B.T.U. Per Cu. Ft.	Exp. 60.—2 Per Cent. Ce O_2 Mantle. Consump. Corr. to 60° F. 760 mm. Cu. Ft.	Total Candles.	Candles Per Cu. Ft.	B.T.U. Per Candle Hour.	Exp. 61.—3 Per Cent. Ce O_2 Mantle. Consump. Corr. to 60° F. 760 mm. Cu. Ft.	Total Candles.	Candles Per Cu. Ft.	B.T.U. Per Candle Hour.
0	595	3.12	51.2	16.4	36.2	3.02	40.0	13.2	44.9
24	585	3.30	54.0	16.4	35.7	3.04	34.4	11.3	51.6
100	586	3.38	48.2	14.2	41.1	2.96	35.0	11.8	49.5
300	593	2.96	47.0	15.9	37.4	2.69	33.4	12.4	47.8
600	594	2.81	47.1	15.7	35.4	..	..	..	..
600	625	..	..	..	..	2 69	38.1	14.2	44.2
900	603	2.83	45.4	16.0	37.6	2.55	36.7	14.4	41.6

TABLE IV.—*Exp.* 63 *and* 64.

Hours Burned.	Net Heat. Value Gas. B.T.U. Per Cu. Ft.	Exp. 63.—0.5 Per Cent. Ce O_2 Mantle. Consump. Corr. 60° F. 764 mm. Cu. Ft.	Total Candles.	Candles Per Cu. Ft.	B.T.U. Per Candle Hour.	Exp. 64.—1 Per Cent. Ce O_2 Mantle. Consump. Corr. 60° F. 760 mm. Cu. Ft.	Total Candles.	Candles Per Cu. Ft.	B.T.U. Per Candle Hour.
0	603	3.53	56.2	15.9	37.9	3.40	59.1	17.4	34.7
24	586	3.27	51.9	15.8	36.0	3.19	58.9	18.5	31.7
100	595	3.27	48.3	14.8	40.3	3.20	57.5	18.0	33.2
300	599	3.17	43.1	13.6	44.0	3.05	50.2	16.5	36.4
600	625	3.07	36.4	11.9	52.7	3.13	49.6	15.8	39.5
900	628	3.20	38.6	12.1	52.1	3.06	42.8	14.0	44.9

TABLE V.—*Exp.* 65 *and* 66.

Hours Burned.	Net Heat. Value Gas. B.T.U. Per Cu. Ft.	Exp. 65.—2 Per Cent. Ce O_2 Mantle. Consump. Corr. 60° F. 760 mm. Cu. Ft.	Total Candles.	Candles Per Cu. Ft.	B.T.U. Per Candle Hour.	Exp. 66.—3 Per Cent. Ce O_2 Mantle. Consump. Corr. 60° F. 760 mm. Cu. Ft.	Total Candles.	Candles Per Cu. Ft.	B.T.U. Per Candle Hour.
0	603	3.00	51.6	17.2	35.1	3.08	44.8	14.5	41.5
24	586	2.92	48.9	16.7	35.0	3.13	38.3	12.2	47.8
100	595	2.76	48.2	17.5	34.1	2.92	39.3	13.4	44.2
300	599	2.82	48.1	17.1	35.1	2.91	38.4	13.2	45.5
600	625	2.64	44.0	16.7	37.5	2.80	39.1	14.0	44.8
900	628	2.69	46.5	17.3	36.1	2.78	39.3	13.7	44.3

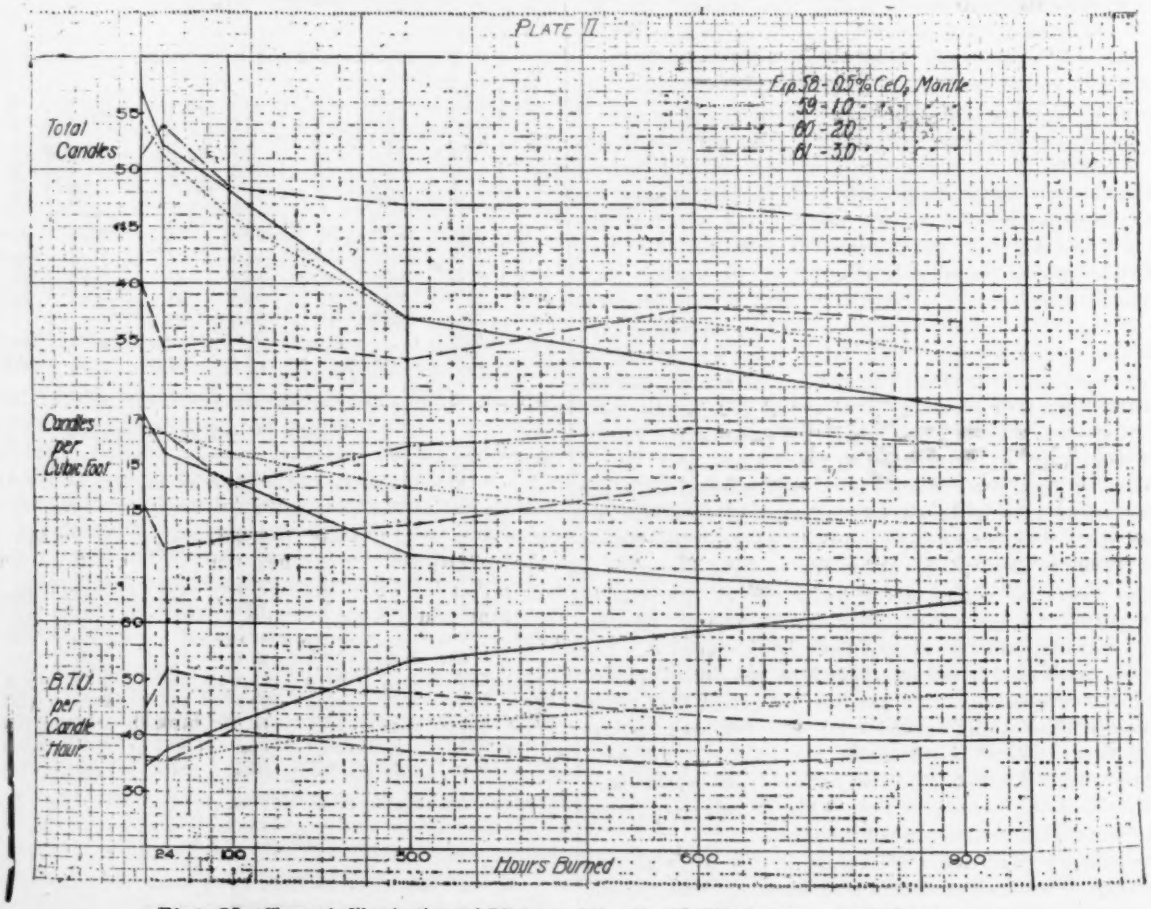

Plate II.—Change in Illumination and Efficiency of Mantles with Differing Percentages of Cerium.

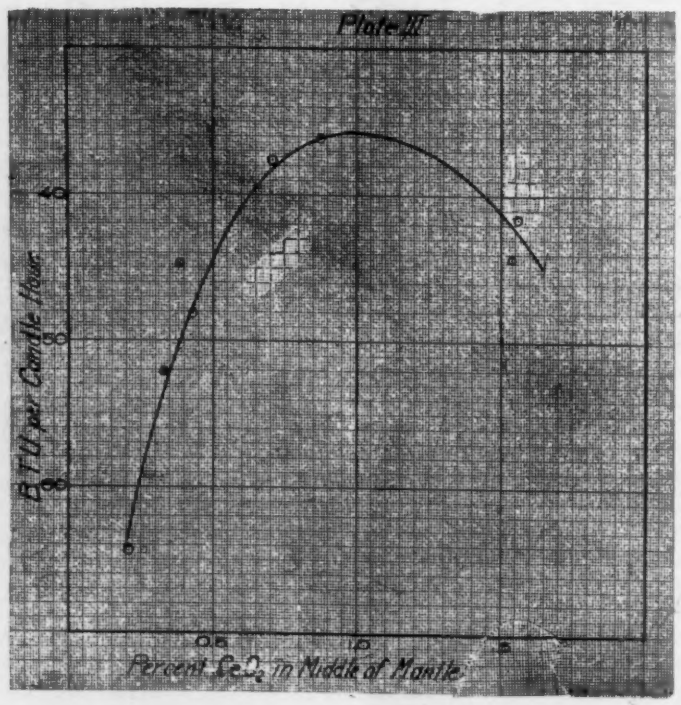

Plate III.—Relation between Percentage of Cerium and Efficiency in Old Mantles.

its vortex, the point of highest efficiency, at about 1 per cent. cerium content, and the efficiency decreasing in both directions with change in the percentage of cerium. This is in general accord with the well known facts about the efficiency of different mixtures of thoria and ceria. As these mantles are no longer homogeneous, it is out of the question to compare the results with those obtained from new mantles.

This series of mantles showed clearly what had also been noted in commercial mantles, that the decrease in the percentage of cerium changed the color of the light. With higher percentage of cerium the light is yellow. As the cerium drops to about 1 per cent. the light becomes more nearly white. As the cerium drops below 1 per cent. it becomes more of a green.

Our earliest tests were made entirely on American mantles, but later we obtained, through the kindness of Dr. Bunte, a number of samples of three of the best known German makes. These came to us already burned off and shellacked. The manufacturers claim that shellacking injures the illuminating power, but as American mantles are all put on the market in this form it was deemed fair to use the shellacked German mantles. With the mantles came some of the German Auer burners, and an attempt was made to test them according to the methods of the German commission (*J. für Gasbeleuchtung*, 43, 665, 1900), which prescribe that a 10-inch chimney shall be used, and that the pressure shall be varied between 1.2 and 1.4 inches and the consumption between 3.5 and 4.4 cubic feet until the highest illumination is obtained. The Auer burner does not possess any way of regulating the air or gas supply except as the latter may be regulated by turning the fixture key, which affects a corresponding change in the pressure. We found that the air supply was too great for our gas and that it was necessary to put metal collars around the burners to control the air supply.

We also found that we could not get the proper amount of gas through the burner at the low pressure specified. The German regulations direct that a proper tip be chosen by trial to give the maximum light. No series of tips came with the burners and we used them as they were furnished to us. This necessitated the use of a 2-inch pressure. The burner was set for highest illumination each time by regulating the air supply. An attempt was made to run a parallel series, keeping the consumption constant at the amount determined to be proper for the first day, but the light could not be kept steady on some days and this test was abandoned. Tests were also made with these mantles on American burners. These mantles on the American burners started higher but deteriorated more rapidly. These phenomena are probably associated. The adjustable air and gas supply allowed a more perfect regulation of the conditions of combustion, giving a higher temperature and more light with correspondingly rapid deterioration. One of the German mantles actually made good its claim of increasing in illumination for more than 1,000 hours. The curve shows the usual irregularities, but a fair line struck through the points shows a distinct increase both in candles and candles per cubic foot during the 52 days' burning. The photometric results are tabulated below. Unfortunately, an accident in the analysis of this mantle prevents us from giving the chemical composition of the mantle after burning, but the composition of the new mantle was 1.27 per cent. of ceria.

Days Burned.	Cons.	Net Heat Value of Gas. B.T.U. per Cu. Ft.	Atmos. Mixture. Grains per Cu. Ft.	Candles.	Candles per Cu. Ft.	B.T.U. per Candle Hour.
0	3.54	593	3.4	60.3	17.0	34.9
1	3.45	591	3.3	60.4	17.5	33.7
5	3.42	582	3.2	61.5	18.0	32.5
9	3.46	585	4.6	62.9	18.2	32.1
13	3.32	583	4.7	57.2	17.2	33.8
16	3.45	578	5.4	60.7	17.6	32.8
20	3.56	579	3.6	63.5	17.8	32.5
23	3.51	589	3.5	66.2	18.8	31.2
27	3.38	585	3.9	62.4	18.5	31.7
33	3.39	579	2.9	60.3	17.8	32.5
37	3.56	578	3.1	64.7	18.2	31.8
46	3.35	579	4.0	62.5	18.7	31.0
52	3.44	591	4.5	61.4	17.8	33.1

In considering the reasons for the volatilization of the cerium, it did not seem impossible that a marked deficiency of air supplied to the burner might cause carbon monoxide in a strongly reducing atmosphere to form a volatile cerium carbonyl. To test this a mantle was started with the air supply so restricted that there was a very noticeable flame envelope outside of the mantle. Under these circumstances the mantle gave a poor light and was evidently at a low temperature. For photometric measurements it was brought back to its normal method of burning. After burning for 42 days in this manner the mantle retained its original candle power and efficiency unimpaired. It was then burned with proper air supply, with the result that an immediate deterioration was noted. After burning 23 days more it was stopped, having burned in all 1,560 hours. In the last period of 23 days it dropped from 61 to 42 candles, and its efficiency fell from 19 to 12 candles per cubic foot. The analysis of this mantle showed in the middle .39 per cent. of cerium, while the bottom, representing the original composition of the mantle, contained 1.05 per cent. The photometric results indicate that this loss of cerium took place almost entirely in the second period, when the mantle was burning properly. A deficient air supply, so far from impairing the mantle, seems to have preserved it during the first period by keeping its temperature below that at which the cerium volatilizes.

It seemed also possible that sulphur compounds in the gas, forming sulphurous and sulphuric acids in combustion, might be responsible for the loss of cerium. The very large percentage of sodium sulphate in the chimney deposits lent color to this idea. As no way presented itself of readily removing the organic sulphur always present in the gas, the influence of an excessively large amount of sulphur was studied. For this purpose hydrogen sulphide was introduced into the gas in amount about equal to 100 grains sulphur per 100 cubic feet, an amount 10 times greater than normally present. Tests on two mantles burned under these conditions failed to give any evidence of abnormally rapid deterioration. We cannot ascribe any marked influence to the presence of sulphur.

The suggestion has been made that the use of water gas is responsible for the more rapid deterioration of mantles in this country than in Germany. We have not had available a continuous supply of water gas, but tests made through the kindness of Mr. A. F. Traver, of the Grand Rapids Gas Company, indicate that water gas does not necessarily exert a harmful effect.

In a test of two similar mantles, one burning carburetted water gas of an average candle power of 25 and the other a coal gas of 15-candle power, the mantle on water gas, after 24 hours' burning, was giving 115 candles, or 32.9 candles per cubic foot, and after 1,150 hours was still giving 91 candles, or 21.2 candles per cubic foot. The mantle burning on coal gas, after 24 hours, gave 96 candles, or 21.3 candles per cubic foot, and after 1,272 hours, 72 candles, or 14.4 per cubic foot. Both mantles remained in good physical condition until breaking chimneys stopped the tests. The much higher candle power of the mantle burning rich water gas is confirmatory evidence of the influence of the heating value of the gas on illumination. Although this mantle stood the test of continuous burning on water gas without visible physical deterioration, some mantles have shown a marked tendency to crumble at the level of the cap in the intense heat of the water gas flame. It is naturally a more severe test of a mantle to subject it to a very hot flame than to keep it at a lower temperature.

Our study of the subject of the deterioration of mantles while burning leads us to the following conclusions: The physical changes which take place in well made mantles are relatively unimportant. The greatest cause of the gradual deterioration is the loss of cerium oxide, which slowly volatilizes in the intense heat. Experiments on mantles containing originally more than 1 per cent. of cerium indicate that their efficiency increases until the cerium content of the hot zone has dropped to about 1 per cent., and that from that point on they deteriorate. The rate of deterioration of commercial mantles varies greatly, but the important factor is still the decrease in the percentage of cerium. Some mantle manufacturers are able to very greatly lessen the rate of loss of cerium and thus make mantles which retain their efficiency for long periods. Our experiments do not suport the theory of periodic change in the mantle's illumination but confirm the position previously taken that the alteration of the heating power of the gas, with its consequent effect on the temperature of the mantle, is the most important factor in causing the fluctuations in the illuminating power of a mantle from one day to the next. The amount of moisture in the atmosphere also exercises an appreciable influence.

A Soft Answer Burneth Away Chaff.

[By Mr. George G. Ramsdell.]

When Mr. Brown read his paper, "Why Milwaukee Did Not Build Inclines," at the meeting of the American Gas Light Association held in New York, in 1902, some surprise was expressed that his challenge was not more adequately answered by those who advocate the inclined system.

We do not believe that this apparent neglect was because of a lack of the courage of their convictions on the part of the believers in inclines, but rather that the records necessary to verify their arguments were not then at hand. Mr. Brown's whole argument must stand or fall upon his claim that a bench of 8 inclined retorts would not produce over 135,000 cubic feet of gas in 24 hours, or, as he put it, "As to the gas made per bench, that assumed for inclines (135,000 per day) I believe to be in excess of any average results now being obtained anywhere."

Even were this claim correct we think the ultimate showing made by his paper is favorable to inclines. However, since that time the new inclined retort house at New Bedford, Mass., has been successfully put in operation, and we give the actual results of the first 27 consecutive days of operation, the gas being corrected for temperature.

Account of Gas Made in Inclined Retorts at New Bedford, Mass., June 8th to July 4th, Inclusive.

Date.	Gas Made.*	Coal Used.	Yield.	Average per Retort.
June 8	182,884	43,840	4.17	15,240
" 9	156,290	43,840	3.56	13,024
" 10	205,100	43,840	4.68	17,092
" 11	223,600	43,840	5.10	18,633
" 12	209,300	43,840	4.77	17,442
" 13	176,910	43,840	4.03	14,742
" 14	184,400	43,840	4.20	15,366
" 15	211,520	43,840	4.82	17,626
" 16	214,351	43,840	4.89	17,862
" 17	219,360	43,840	5.00	18,263
" 18	204,386	42,940	4.76	17,032
" 19	189,600	55,200	3.43	15,800
" 20	195,690	50,400	3.88	16,307
" 21	203,900	48,000	4.24	16,992
" 22	219,610	48,000	4.57	18,310
" 23	230,190	48,450	4.75	19,182
" 24	242,405	48,600	4.98	20,200
" 25	237,194	57,600	4.12	19,766
" 26	238,618	57,600	4.14	19,885
" 27	237,730	48,600	4.87	19,811
" 28	243,970	48,600	4.99	20,331
" 29	243,680	50,400	4.83	20,307
" 30	243,342	50,400	4 83	20,878
July 1	245,867	50,400	4.88	20,488
" 2	236,868	50,400	4.70	19,739
" 3	251,350	50,400	4.98	20,946
" 4	249,300	50,400	4.94	20,775
	5,897,415	1,294,790	4.55	18,202
Average per retort for the 12 days ending July 4th				20,142

*Corrected.

This report shows that, notwithstanding the adjustments necessary to a proper working of the furnaces and the breaking in of men entirely new to the operating of inclined retorts, etc., the average for the 27 days, making no allowance for conditions peculiar to the starting up of a new works, was 18,202 cubic feet, or at the rate of 145,616 cubic feet per day for a bench of 8's, while for the last 12 days of the time the average per retort was well over 20,000 per retort per day, or over 160,000 for a bench of 8's.

It will also be noticed that on the 3d of July the make in 12 retorts was 251,350 cubic feet, equal to 167,568 for a bench of 8's.

We assume that these figures abundantly show what we unhesitatingly claim, that a bench of 8's, 20 feet long, will average, week in and week out, 160,000 per bench per day, using standard American gas coal. The above results were obtained using 6 and 5-hour charges. We believe that when more gas is needed, and 4-hour charges are adopted, 21,000 to 22,000 cubic feet will be as easily produced, equiva-

lent to a production of 170,000 to 175,000 cubic feet per day in a bench of 8's.

We have taken Mr. Brown's exhibits as contained in his paper and added an additional column based upon the make of 160,000 cubic feet per day, which we give below.

While we do not admit or deny the correctness of Mr. Brown's estimates, we have prepared the added column without altering his figures, simply calculating the added figures from the estimates as he has given them but reduced proportionately.

EXHIBIT A.—*Working Capacity of* 4,000,000 *Cubic Feet per Day.*

	Horizontal 8's. 1 Bench.	Inclined 8's. 1 Bench.	Inclined 8's. 1 Bench.
Make per bench, 24 hours	90,000	135,000	160,000
Life per bench, days	900	900	900
Life in 1,000 feet made	81,000,000	121,500,000	144,000,000
Cost of resetting	$550	$1,250	$1,250
" " per 1,000	.0068	.0128	.0087

9. Actual price charged, 25th March, 1902, stating discount if any. Private consumers, 54 cents per 1,000. Public lamps $11.55 per year per lamp, including lighting, cleaning and repairs. Discount 2½ to 20 per cent., according to consumption.
10. Annual charge for meter rent: Provided free of charge.
11. Illuminating power:
    a. Number of candles prescribed 16
    b. Number of candles supplied ..... 17 to 18
12. Total receipts in respect of gas undertaking during the year ending 25th March, 1902, $1,107,902.52.
13. Total expenditure for the year ended March 25, 1902 (exclusive of interest on loan and other items in column 14): $971,927.64.
14. a. Interest paid on loan ..... $59,050.11 + 10
    b. Amount paid for annuities ..... 476.91 + 70
    c. Amount of loan repaid that year ..... None.
    d. Amount paid for redemption of annuities ..... None.
    e. Amount placed to sinking fund ..... 26,425.09 + 50
    $85,952.12

During year ended March 25, 1902, stated separately.

EXHIBIT B.

	Horizontal 8's. 48 Benches. 2 Stacks of 24 Benches Each. House 350' by 72' by 40' Equal 25,000 Sq. Ft.	Inclined 8's. 32 Benches. 4 Stacks of 8 Benches Each. House 474' by 50' by 48' Equal 24,000 Sq. Ft.	Inclined 8's. 27 Benches. 3 Stacks of 9 Benches Each. House 360' by 54' by 50' Equal 19,500 Sq. Ft.
Cost of house, 4,000,000 per day capacity, including stage floors. Last column figured on exactly the same basis as second column.	$85,000.00	$106,000.00	$86,580.00
Foundation on piles	6,000.00	7,500.00	6,045.00
Coal elevators, conveyors and breakers, 50 tons per hour capacity each	15,000.00	15,000.00	15,000.00
Charging apparatus for inclines	....	9,600.00	8,100.00
Stoking machinery, compressor, etc	32,000.00	....	....
Coal bins, 30 hours' supply	6,000.00	12,500.00	10,055.00
Benches	144,000.00	249,600.00	212,288.00
Bench foundations on piles	10,500.00	9,200.00	7,763.00
Connections and drains	4,000.00	3,000.00	2,531.00
	$318,250.00	$424,900.00	$348,372.00
Land at $60 per lineal foot	21,000.00	28,440.00	21,600.00
	$339,250.00	$453,340.00	$369,972.00
Interest at 50 per cent	$16,962.50	$22,667.00	$18,498.60
Depreciation at 5 per cent	16,962.50	22,667.00	18,498.60
	$33,925.00	$45,334.00	$36,997.00
Make of 250 maximum days	1,000,000,000	1,000,000,000	1,000,000,000
Cost per 1,000 made. Interest and depreciation	.0339	.0453	.0369

EXHIBITS D. AND E.

Labor costs per day	$110.00	$105.25	$88.83
" " 1,000	.0275	.0263	.0222

EXHIBIT F.—*Summary.*

	48 Horizontals.	32 Inclines.	27 Inclines.
Exhibit "A."	.0068	.0128	.0087
" "B"	.0339	.0453	.0369
" "D. and "E."	.0275	.0263	.0222
Total	.0682	.0844	.0678

[Concluded from Page 125.]

Something about Gas Works in the United Kingdom.—No. II.

[Prepared for the JOURNAL by MR. FREDERIC EGNER.]

To give the reader an idea of the arrangement of the "returns" under review, the following headings of columns will serve: and to still further illustrate the subject, the figures relating to one of the "undertakings" will also be given. The plant taken as an example is that of the Belfast, (county Antrim, Ireland) Corporation. The headings of columns follow in order, thus:

Name of Local Authority—Belfast Corporation.

1. Acts of Parliament or Provisional Orders. Belfast Gas Act, 1874.
2. Limits of supply, showing separately, districts within and beyond jurisdiction of local authority. City of Belfast.
3. Amount of loan and capitalized value of annuities authorized for purposes of gas undertaking, March 25th, 1902: £600,000 sterling, or $2,919,900.
4. Period within which loan is to be repaid and annuities redeemed: 39 years from 1899.
5. Total amount of money borrowed down to March 25th, 1902, including capitalized value of annuities, not deducting amount repaid: $2,321,950,47.
6. Rate of interest paid on loan, 2¾ to 4⅝ per cent.
7. a. Total amount of loan repaid $554,829.67
   b. Total annuities redeemed ..... None.
   c. Total amount placed to Sinking Fund exclusive of a and b 194,981.18
   $749,810.85
8. Maximum price of gas authorized per 1,000 cubic feet—$1.33.
9. Actual price charged, 25th March, 1902, stating discount if any. Private consumers, 54 cents per 1,000. Public lamps $11.55 per year per lamp, including lighting, cleaning and repairs. Discount 2½ to 20 per cent., according to consumption.
10. Annual charge for meter rent: Provided free of charge.
11. Illuminating power:
    a. Number of candles prescribed 16
    b. Number of candles supplied ..... 17 to 18
12. Total receipts in respect of gas undertaking during the year ending 25th March, 1902, $1,107,902.52.
13. Total expenditure for the year ended March 25, 1902 (exclusive of interest on loan and other items in column 14): $971,927.64.
14. a. Interest paid on loan ..... $59,050.11 + 10
    b. Amount paid for annuities ..... 476.91 + 70
    c. Amount of loan repaid that year ..... None.
    d. Amount paid for redemption of annuities ..... None.
    e. Amount placed to sinking fund ..... 26,425.09 + 50
    $85,952.12

During year ended March 25, 1902, stated separately.

15. Amount of net profit, if any, realized for year ended March 25, 1902, after payment of interest in column 14, and how applied: $50,022.75, partly to borough fund, balance not yet applied.
16. Number of tons of coal carbonized during the year ended March 25, 1902: 91,752.
17. Nature and quantity other materials used for the manufacture of gas during year ended March 25, 1902: Solar distillate, 2,040,452 gallons.
18. Number of cubic feet of gas made during year ended March 25, 1902: 1,683,983,000.
19. Number of cubic feet of gas consumed during year ended March 25, 1902:
    a. Private consumers, etc 1,350,731,200
    b. Public lamps (exclusive of amount consumed at works) 213,770,000
    1,564,501,200
20. If water gas is supplied, state:
    a. Number of cubic feet supplied: 725,708,000.
    b. The maximum proportion of its admixture with coal gas: (a) 725,708,000. (b) About 43 per cent.
21. Length of gas mains in miles: 424.
22. Number of consumers, March 25, 1902 (calculated according to number of accounts): 42,187.
23. Number of public lamps lighted during the year ended March 25, 1902, and whether supplied free of charge: 9,907.

Thus far the "Official Return." The works are under the evidently efficient management of Mr. James Stelfox, whom the writer was much pleased to meet and ride with in "An Irish Jaunting Car" some 6 years ago. The works were visited and found in every respect modern and clean and a credit to the corporation and its engineer.

A word of caution to the reader at this time may not be out of place. It is generally known perhaps, but not always remembered, that the purchasing power of a dollar in the United States and abroad—Ireland for instance—differs greatly. Gas at Belfast at 54 cents per 1,000 cubic feet is relatively *not* as cheap as gas at $1 per 1,000 cubic feet at New York. It will be observed, for instance, that the Belfast Corporation was able to borrow the capital which it required at from 2¾ to 4⅝ per cent. Doubtless, no American gas company has yet been able to obtain money upon such favorable terms. When on the spot six years ago, the writer found that retort house firemen and all other labor received *less* than one-half the compensation paid here with us at this

time, not to mention the days when $3.50 and $4 per day were commanded by the very independent stoker of 20 years ago.

The smallest of the municipal gas undertakings is that of the Wenlock Corporation, Shropshire. Only one million cubic feet of gas was made and 750,000 sold. "About" one mile of street mains with 65 consumers and 40 public lamps seems to be the limit for the year reported. Coal gas was manufactured, for which 200 tons of coal were required. The largest of the municipal plants is that at Glasgow, Scotland, where 5,422,367,500 cubic feet of gas was sold in the year ending with March 25th, 1902. The smallest of the "Authorized" gas companies' plant is probably that at Lampeter, Cardiganshire, where 100 tons of coal ("about") were used to produce an amount of gas which the table states "cannot be given." But they have "about" one mile of street mains, with 73 consumers and 33 street lamps to supply.

The largest is of course The Gas Light and Coke Company, of London, which was previously mentioned.

The tables of this "Official Return" of private gas companies show so many plants paying from 9 to 12 *and more* per cent. annual dividends that the writer could not help wondering if those who "*make money*" by the delightfully lawful and not so very difficult method of buying gas properties at *any* price, and then getting the printing presses at work turning out bonds and other securities (?) the quantity being limited only by the earning capacity, and *then* selling same for *real* money, how this great opportunity has ever escaped their perception. It cannot be that they are satisfied, for that would scarcely be natural; or does the law of the United Kingdom act as an effectual stopper upon these very profitable modern financing practices? It is "perfectly honest, you know," and, therefore, why such regular bonanzas have escaped to date is somewhat remarkable.

The Synthetic Cyanide Process.

In a paper, read by Dr. Fritz Roessler, of Frankfort-on-Main, at the Berlin International Congress of Applied Chemistry (a free translation of which has been published by the *Journal of Gas Lighting*), the author remarked:

The present world's consumption of cyanide may be said to be supplied by four synthetic processes, leaving out of account the ever-diminishing quantities made from potassium ferro-cyanide and sodium, and the cyanogen obtained from beet sugar residues (schlempe) as not being, properly speaking, synthetic processes. The four processes are: Siepermann's process in Stassfurt, Beilby's process in Glasgow, the Raschen process of the United Alkali Company, and the improved Castner process. Far away the greater part of the many other cyanide processes patented have never reached the practical manufacturing stage, because the inventors overlooked the fact that, for practical purposes, the important matter is not to discover a new method of synthesizing cyanides, but to find a practical and cheap way of producing a salable, commercial article.

The difficulties which are to be overcome in producing a finished, commercial product from the cyanide containing mixtures obtained in most synthetic processes are well exemplified by the Stassfurt process, as described in recent patents. This process, like that of Beilby, sets out from potash, charcoal, and ammonia. To-day, ammonia still remains the only source of nitrogen used in the synthetic processes which are actually producing cyanide. The reactions given by Siepermann as representing his process are:

$$K_2CO_3 + NH_3 = KCNO + KOH + H_2O.$$
$$KCNO + C = KCN + CO$$

According to more recent researches, the process appears, however, to take place as follows:

$$K_2CO_3 + NH_3 = CO.NH_2.OK + KOH$$
$$CO.NH_2.OK = KCNO + H_2O$$
$$2\,KCNO = K_2N_2C + CO_2$$
$$K_2N_2C + C = 2\,KCN$$

The separation of the various products of the reaction is accomplished by means of their different solubilities at different temperatures.

Beilby has succeeded in avoiding the difficulties of lixiviating, and obtaining the cyanide from aqueous solution by working directly for a high strength fused cyanide. He succeeded in this by reducing the melting point of the working mixture by adding ready made cyanide to it.

The United Alkali Company's process, which consists essentially in the oxidation of sulphocyanides with nitric acid, is, from the chemical standpoint, a very elegant process. Technically, however, it is extremely complicated; and, above all, it does not produce a fused product.

The cyanogen content of pure sodium cyanide is proportionally higher than that of pure potassium cyanide; but until recently it was not possible to produce pure high strength sodium cyanide. The working out of the Castner synthesis from metallic sodium and ammonia has now, however, led to this result. Castner himself gave the following equations as representing his process:

$$Na + NH_3 = NaNH_2 + H$$
$$NaNH_2 + C = NaCN + H_2$$

It has been proved, however, that the reaction is more complicated; it taking place as shown in the equations:

$$Na + NH_3 = NaNH_2 + H$$
$$2NaNH_2 + C = Na_2CN_2 + 2H$$
Or $$NaNH_2 + NaCN = Na_2CN_2 + H$$
$$Na_2CN_2 + C = 2NaCN$$

Although metallic sodium is a comparatively costly raw material, this synthesis is considerably cheaper than that which sets out from soda, charcoal, and ammonia, as the apparatus is simple, and the yields are good. It is noticeable here, as in other cases, that in synthetic processes it is most important to set out from raw materials of the greatest possible purity, even though their preparation is attended with considerable expense.

Considering the many synthetic methods of preparing cyanides which have been proposed, in the light of practical experience, it is obvious that by far the greater part of them merely attempt to synthesize cyanides or hydrocyanic acid, and that they quite overlook the enormous difficulties which arise when an attempt is made to prepare a commercial finished cyanide from the cyanogen containing materials obtained. This is especially true of the many processes which attempt to work with atmospheric nitrogen. None of these have so far been successful, although the raw material cost nothing. The cost of producing the high temperature, the destruction of apparatus, and the cost of purifying the product obtained are excessively high.

Practical Factory Sanitation.[1]

A recent bulletin of the Department of Labor, on "Factory Sanitation and Labor Protection," merits a much wider and more general circulation than the method of distributing Government publications promises to secure for it. While by no means a comprehensive discussion of the subject to which it relates, and touching only a few of the many evils incident to the neglect in workshops of precautions essential to health and comfort of men and women employed therein, it is suggestive and will well repay thoughtful study by every employer of labor. It will make it reasonably evident to the appreciative reader that there is room for a new profession—that of sanitary engineering applied to workshop conditions. It is one which demands the preparation of large experience and an intimate knowledge of industrial conditions. Not only every mechanical trade, but every shop, presents problems of its own which, if solved intelligently, must be dealt with with reference to facts as one finds them, with men as their social environment has made them, and with localities according to climate, humidity and whatever must be considered in the judicious selection and development of a manufacturing site.

Successful workshop sanitation calls for a knowledge of many sciences and practical familiarity with economic conditions. The amateur in such matters is likely to be found an impractical and unsafe adviser. The zeal of the radical reformer needs to be tempered by the discretion which is gained only from experience in dealing with masses of average men who are more likely at first to obstruct than to co-operate with measures designed to conserve health and promote comfort. Often the attainment of satisfactory conditions is possible only by gradual approaches, time being given for the formation of new habits and the gradual raising of the standards of judgment in matters pertaining to comfort and decency. The employer who, impressed with the idea that his workshop conditions are not what they should be, goes too fast and too far in an effort to make them "ideal," is usually disappointed in the outcome, with the result that he abandons further effort, regrets the expense and trouble he has already incurred, and decides that since his work people are too indifferent or too careless to co-operate with him in carrying out his plans for their benefit, he will in future remain content with what they find satisfactory. This is superimposing one mistake upon another, both of which might have been avoided had he put himself under wise guidance and taken only such steps as would have commanded the co-operation of his work people. A certain amount of pressure is usually necessary to enforce on the part of the indecent a proper respect for the rights of the decent. This cannot be effectively exerted if too many new rules need to be enforced at once. Practical tenement house reform, which we now have in New York for the first time, illustrates the fact that confidence in

1. *Iron Age*

any form of disinterested benevolence is a plant of slow growth. What is now being accomplished in improving the domiciliary conditions of the poor in New York would probably be impossible if it had not been approached through years of effort, most of it apparently without benefit and destructive of altrusistic impulses on the part of the official and the philanthropist.

It should be remembered, however, that there is nothing altruistic in the creation and maintenance in workshops and factories of conditions favorable to health and comfort. The efficiency of labor employed indoors in monotonous occupations depends very largely upon the minimization of dangerous and uncomfortable conditions. The man who is dull and logy, who must fight to keep himself awake, and whose intelligence is blunted and his strength sapped by continued breathing of a vitiated or poisoned atmosphere, cannot be an efficient workman, and is not cheap even at low wages. Pure air is indispensable to the normal man, and this is not always easy to obtain in crowded neighborhoods, even when "all out-doors" is drawn upon. It depends a good deal upon what stratum of the atmosphere is tapped, so to speak, whether what is had is stimulating and invigorating or depressing and enervating. This is a matter of expert judgment, assisted by chemical and bacteriological analyses. Factory and workshop ventilation presents no great difficulties if undertaken intelligently, but it involves a good many things which must be taken into account, and which, if overlooked or neglected, will destroy the best laid plans. The air vitiated by lung exhalations, by dust and by smoke and fumes must be disposed of before room is given either for fresh air to enter or for it to be of service when it does enter. It is obvious that specific suggestions as to ways and means would be not merely valueless but misleading. Each building, and very often each room in the building, has to be studied as a problem by itself, and dealt with as conditions peculiar to itself and to the occupations conducted within it, its normal population and the character of its occupants may demand. As the rule, factories are so built as to make good ventilation as an afterthought a matter often involving great ingenuity. The employer of labor does not, however, need to consult others as to whether the conditions to which his work people are exposed during working hours are good or bad. He can tell this for himself by walking through the shops and noting not merely his own sensations but what he may see without effort. If led by the instinct of self interest into well directed effort to make the conditions as good as he can, the results will be abundantly and satisfactorily compensatory.

The condition of the floors will usually be found to demand thoughtful attention. Floors which cannot be kept clean, and into which the dirt and grime of years are ground, should be subject to indictment as public nuisances, "dangerous to life and detrimental to health." When such a floor becomes the ceiling of the room below, and every movement over or across it sends its load of dirt sifting down through cracks and knot holes upon those below, the danger is doubled. No material is suitable for a factory floor which cannot be kept clean, and upon which it is not possible to turn the stream from a hose as often as it is necessary. Accumulations of rubbish on floors should be avoided. They are a source of many dangers, and when they are found it is safe to conclude that the shop management is slack. A dirty, littered, dust laden shop cannot possibly be a safe shop to work in, and labor employed therein cannot be utilized to good advantage.

Shop illumination is also of great importance. A dark shop, or one with strong and blinding cross lights and deep shadows, is not one which can be operated to advantage. Comparatively few shops are so well lighted that the illumination could not be improved, especially in cases where the growth of an industry has caused shop buildings, old and new, to form unexpected groupings. Probably nothing pays better than plenty of light of the right kind, and where daylight cannot be depended upon electricity in its later developments is an efficient substitute, costing less than it is worth when needed at all. At this season of the year the question of shop lighting commonly gives very little trouble and is likely to be forgotten; but the fact should be borne in mind that during at least six, and in some cases seven months out of the twelve it is a matter of very serious concern, and that the time to provide light is when it is not immediately needed.

Shop heating is a matter worthy of more consideration than it is usually given. Work indoors is rarely done to advantage in a temperature much below 60° F., and the man at the bench who has cold feet and hands is not an efficient mechanic, however faithful to his responsibilities. An artificial temperature maintained above 75° is as unsuitable for sustained industry as one below 60°. Men can and do work in temperatures very much higher than this, but it is in short shifts and calls for the putting forth of supreme effort to accomplish results, which is very different from well directed industry sustained through 9 or 10 hours. Such matters do not often automatically regulate themselves. A foreman will find it advantageous to keep an eye to the thermometer in the shop under his charge.

Toilet facilities cannot be discussed profitably on broad lines. What may be proper and sufficient depends largely upon the class of labor employed, but in every instance decent and strictly sanitary appliances are found to be more satisfactory than those which revolt and shock workmen not brutalized by habitual contact with them. It may be assumed that if better than average facilities are provided the average man will not take great trouble to preserve them in ideal condition until it is impressed upon him that it is to his interest to do so. This means that the employer who wants his washrooms and toilet rooms to be in a condition permitting inspection at all times must make provision for having them taken care of.

Where matters of this kind are intrusted to wisely selected and properly qualified experts much better results are reached than if they have spasmodically engaged the attention of one after another of the official staff, and been neglected in the intervals. The large manufacturing industries are beginning to handle the problems of shop sanitation wisely and comprehensively, but in the smaller shops the conditions usually found warrant the suggestion that there is room for the new profession of expert in the department of sanitary engineering which deals especially with the problems of the workshop. It is not impossible that in the near future organized labor will take a more intelligent interest in matters affecting the life and health of workmen, and insist under good advice upon the correction of conditions calling for improvement. This would be a wise and beneficent use of the power of organization, and in the hands of intelligent leaders would make for good.

The Rateau Steam Turbine.[1]

A type of steam turbine which has come into considerable prominence abroad is that invented by M. A. Rateau, of Paris, and which is now being manufactured in France by Sautter-Harlé & Cie, and in Switzerland at the Oerlikon Works. Through the courtesy of the inventor we are enabled to give an account of the principles of this turbine, which we preface with a description of the construction of this machine.

In Fig. 1 are shown two of the bucket wheels, and in Fig. 2 several guides. Fig. 3 shows a turbine with the upper half of the casing removed and containing only the bucket wheels. Referring in general to the latter figure, live steam is admitted in a chamber to the left, and passing through ports or nozzles in a diaphragm, has its pressure transformed to jet velocity. The jets then strike the blades of the first wheel, then enter the first guide, passing thence to the second wheel, and similarly with respect to the remaining guides and wheels of the first stage. At the end of this stage the velocity of the steam jets is reduced approximately to zero. It then passes through ports or nozzles and starts on its second stage. In these nozzles the pressure, that is, the difference between the first stage pressure and the exhaust pressure —is transformed into jet velocity as previously, and the same process follows that took place in the first stage.

The wheels of the second stage have a greater diameter than those of the first stage in order to reduce the depth of the buckets and also to maintain a proper relation between jet and peripheral velocity. The steam ports and nozzles only take up a portion of the circumference of the stage diaphragm; and in each stage the first guide plate has the least guide openings, each succeeding guide having a progressively increasing number.

The peripheries of the guide plates are fitted and secured steam tight to the turbine casing, but a clearance of from $\frac{5}{32}$ to $\frac{6}{32}$-inches is left between the shaft and the edge of the shaft opening in the plates. The clearance between the bucket and guide plates at the working portions is about $\frac{1}{4}$ inch. M. Rateau admits that there is a loss through friction between the surfaces of the bucket and guide plates which is absent in the Parsons system of steam turbine construction.

Regulation is obtained by means of a centrifugal governor acting on a valve in the admission steam pipe. In the case, however, of machines which are rarely called upon for full load, the width of the openings of the first stage nozzles is varied by an appropriate mechanism. When a machine may for a short time be called upon for a large overload, as in electrical generation, or when the exhaust is diverted from the condenser to the atmosphere, provision can be made for maintaining normal speed by an auxiliary supply of live steam at some intermediate point, such as at the beginning of the second stage.

Among the claims made for the Rateau turbine are: 1. High mechanical efficiency combined with lowest possible angular velocity of bucket wheels. 2. Sufficient clearance between moving and fixed

1. *Elec. World.*

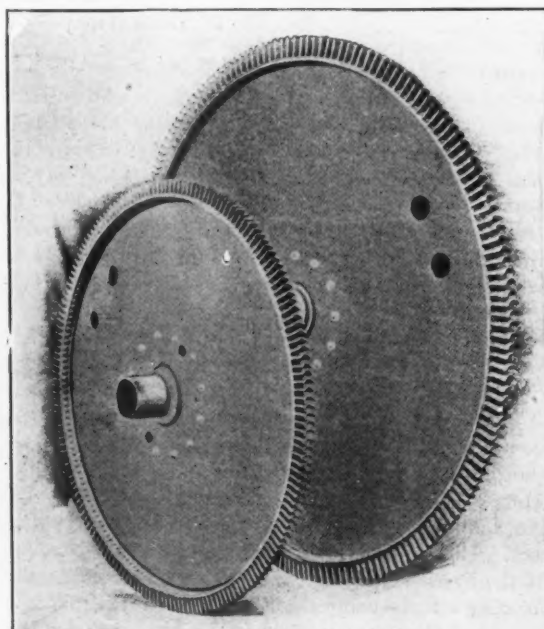

Fig. 1.—Two Bucket Wheels.

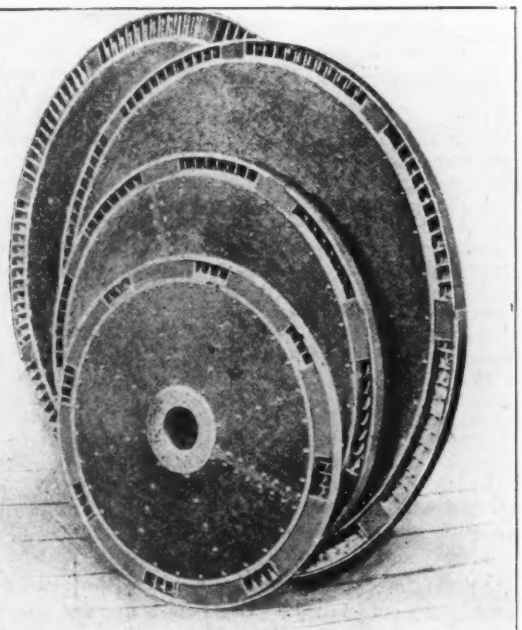

Fig. 2.—Guides.

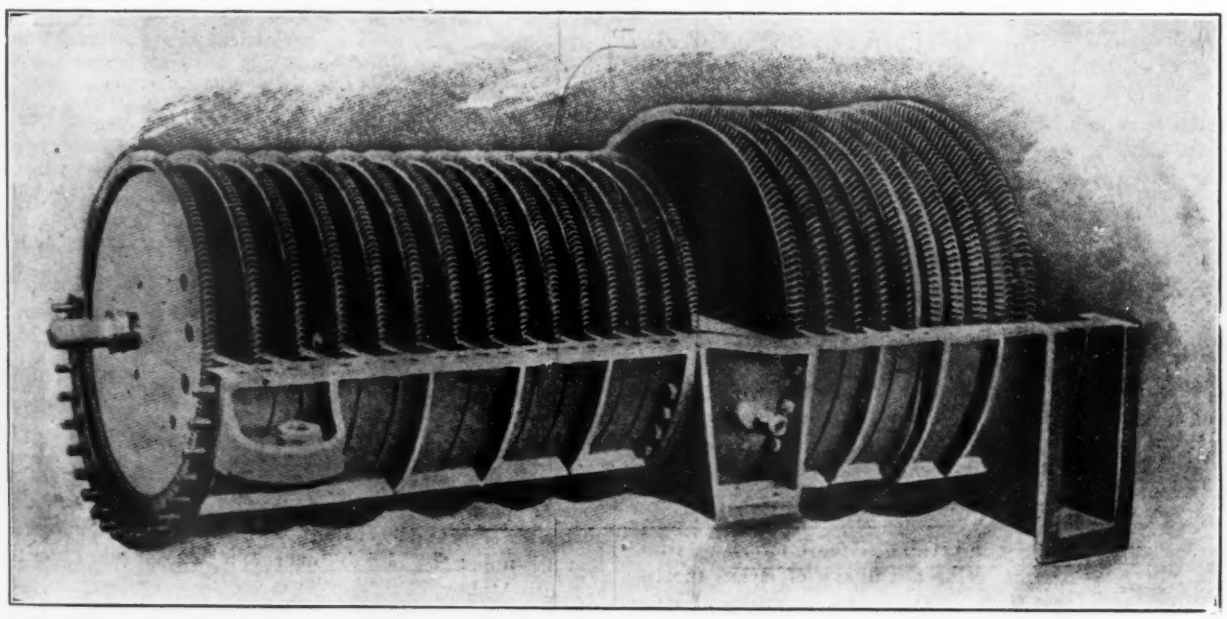

Fig. 3.—Steam Turbine with Upper Half of Casing Removed.

parts to allow for any possible wear of bearings and for shaft flexure. 3. Great lightness as a whole and particularly of the rotating parts, thus reducing gyroscopic effect to a minimum—this latter point being one of importance in turbines for marine use. As illustrative of the second statement, a machine of 1,000 to 1,200-horse power does not exceed 1,100 pounds in weight.

For the following discussion of the theory of the Rateau turbine and account of tests, we are indebted to M. Rateau.

Before giving the figures obtained in the tests, it is convenient to define exactly efficiency, as that term is used by M. Rateau. Too often manufacturers or designers are satisfied by measuring the steam consumption either per indicated horse power, or per effective horse power, on the shaft, without giving the figures for the initial pressure of the steam and the exhaust pressure. This method of describing performance of a machine is not sufficient; one might just as well give for a hydraulic turbine only the quantity of the water without the height from which it falls.

In the tests from these turbines, M. Rateau determined the efficiency from the ratio of the theoretical steam consumption of an ideal perfect machine to the real steam consumption, referred to the power available at the shaft. In the case of electric generating sets, it is preferable to refer this real steam consumption to the electric power measured at the terminals of the dynamos. The theoretical steam consumption is defined as corresponding to the maximum work which the steam can produce under the conditions under which it is delivered to the machine, by expanding adiabatically and without losses from the initial pressure P, to the exhaust pressure p. This method presented some difficulty in calculation, but a diagram may be plotted from which the theoretical consumption can at once be found for saturated dry steam. Such a diagram shows how extremely important it is for economical operation, to have as perfect a vacuum as possible in the condenser, in order to diminish the exhaust pressure p. The expansion is better and the steam consumption is considerably improved by better vacuum, as may easily be seen from the following example:

If a machine is using saturated steam at a pressure of 213 pounds per square inch and by exhausting into free air, the diagram shows that the theoretical steam consumption is 12.85 pounds per horse power hour; if we provide the same machine with a condenser which reduces the exhaust to 27 inches, the theoretical steam consumption is only 7.82 pounds, *i.e.*, 39.3 per cent. smaller than before.

Data will first be given of a turbo generator of 540 electric horse power, which is one of three similar machines, made in the Sautter-Harlé works for the Peñarroya mines in Spain, where they have just been installed. These consist each of two turbines of high and low pressure direct coupled to direct current dynamos, giving each at normal load of 830 amp. at 220 volts. The normal speed is 2,250 r.p.m. These turbines operate with condensation which is effected by ejector condensers of the Rateau type. As the boilers give steam under pres-

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Among the claims made for the Rateau turbine are: 1. High mechanical efficiency combined with lowest possible angular velocity of bucket wheels. 2. Sufficient clearance between moving and fixed

1. *Elec. World.*

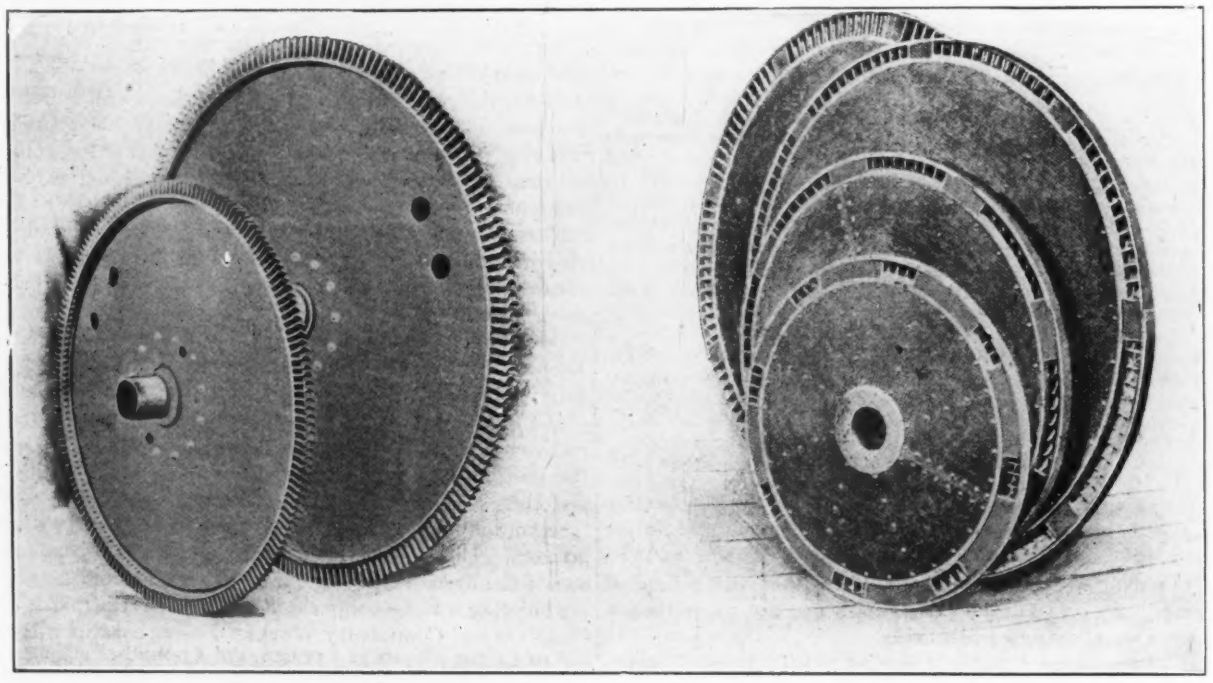

Fig. 1.—Two Bucket Wheels.

Fig. 2.—Guides.

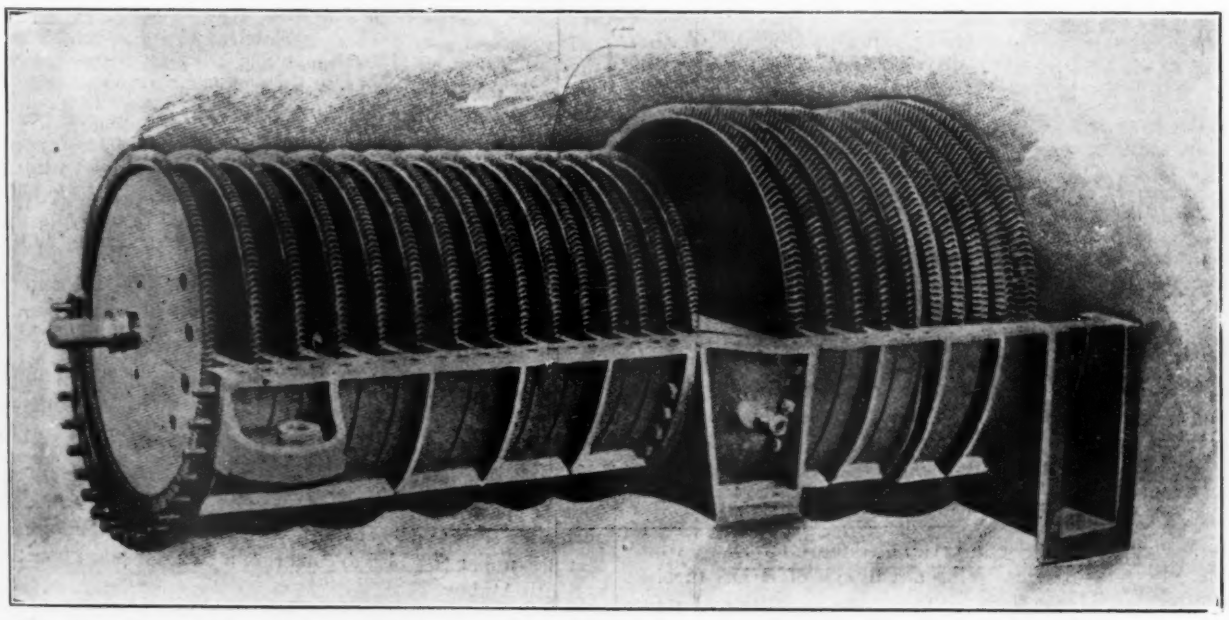

Fig. 3.—Steam Turbine with Upper Half of Casing Removed.

parts to allow for any possible wear of bearings and for shaft flexure. 3. Great lightness as a whole and particularly of the rotating parts, thus reducing gyroscopic effect to a minimum—this latter point being one of importance in turbines for marine use. As illustrative of the second statement, a machine of 1,000 to 1,200-horse power does not exceed 1,100 pounds in weight.

For the following discussion of the theory of the Rateau turbine and account of tests, we are indebted to M. Rateau.

Before giving the figures obtained in the tests, it is convenient to define exactly efficiency, as that term is used by M. Rateau. Too often manufacturers or designers are satisfied by measuring the steam consumption either per indicated horse power, or per effective horse power, on the shaft, without giving the figures for the initial pressure of the steam and the exhaust pressure. This method of describing performance of a machine is not sufficient; one might just as well give for a hydraulic turbine only the quantity of the water without the height from which it falls.

In the tests from these turbines, M. Rateau determined the efficiency from the ratio of the theoretical steam consumption of an ideal perfect machine to the real steam consumption, referred to the power available at the shaft. In the case of electric generating sets, it is preferable to refer this real steam consumption to the electric power measured at the terminals of the dynamos. The theoretical steam consumption is defined as corresponding to the maximum work which the steam can produce under the conditions under which it is delivered to the machine, by expanding adiabatically and without losses from the initial pressure P, to the exhaust pressure p. This method presented some difficulty in calculation, but a diagram may be plotted from which the theoretical consumption can at once be found for saturated dry steam. Such a diagram shows how extremely important it is for economical operation, to have as perfect a vacuum as possible in the condenser, in order to diminish the exhaust pressure p. The expansion is better and the steam consumption is considerably improved by better vacuum, as may easily be seen from the following example:

If a machine is using saturated steam at a pressure of 213 pounds per square inch and by exhausting into free air, the diagram shows that the theoretical steam consumption is 12.85 pounds per horse power hour; if we provide the same machine with a condenser which reduces the exhaust to 27 inches, the theoretical steam consumption is only 7.82 pounds, *i.e.*, 39.3 per cent. smaller than before.

Data will first be given of a turbo generator of 540 electric horse power, which is one of three similar machines, made in the Sautter-Harlé works for the Peñarroya mines in Spain, where they have just been installed. These consist each of two turbines of high and low pressure direct coupled to direct current dynamos, giving each at normal load of 830 amp. at 220 volts. The normal speed is 2,250 r.p.m. These turbines operate with condensation which is effected by ejector condensers of the Rateau type. As the boilers give steam under pres-

sure of from 140 to 210 pounds, a reducing valve maintains the pressure of admission at 140 pounds per square inch as maximum. The consumptions and the efficiencies are given in the following tables:

	Quarter Full Load.	Half Full Load.	Full Load.	Over Load.	Over Load at 2,400 Revolutions.
Electric horse power produced (measured at the brushes)..	135	259	525	627	641
Pressure in pounds per square inch of steam admitted (gage)	31	61	121	141	141
Pressure in pounds per square inch of exhaust steam (pounds)....	1.247	1.34	1.64	1.82	1.82
Theoretical consumption in pounds per horse power for a perfect machine.....	10.91	9.77	8.82	8.71	8.71
Consumption found in tests per electric horse power measured at the brushes.....	21.3	18.0	15.74	15.31	14.86
Combined efficiency of generating set..	0.513	0.540	0.560	0.569	0.586

This table shows that the combined efficiency, *i.e.*, that of turbine and dynamo together, varies between 51 and 58.6 per cent., while the steam consumptions per electric horse power may be as low as 14.86 pounds. If the data are plotted it will show that the combined efficiency is practically constant, its variations being not more than 8 per cent., between overload and ¼ full load.

It has recently been claimed that with respect to efficiency and steam consumption, the turbines are economical only when operated at full load. The above example shows that this criticism is unfounded. In fact, the curve of steam consumption shows that the consumption at no load, with excited dynamos, is only about 10 per cent. of the consumption at full load (tests of other Rateau turbines have given figures varying between 8 and 12 per cent.). On the other hand, for an electric generator driven by a piston engine, the consumption at no load is between 15 and 25 per cent. of the consumption at full load, and these figures refer to the better types of machines of this class.

In the case of a turbine driving a 4-wheel centrifugal pump working at from 90 to 140-horse power, the combined efficiency of turbine and pump together was as high as 36 per cent., and did not fall below 31 per cent.; this corresponds to an efficiency of about 67 per cent. for the pump and 54 per cent. for the turbine.

By the use of condensing and by producing a vacuum of 24 to 27 inches in the condenser, it is possible to utilize steam at low pressure for the operation of turbines and to obtain quite satisfactory figures for steam consumption and efficiency. This is a considerable advantage of turbines over piston engines. In fact, if a machine of the latter type was to be operated with steam of a pressure of about 14 pounds' pressure, one would get an excessively cumbersome machine, too expensive to install, and of an efficiency which would be low for several reasons, the main reason being the very important condensing losses which would take place in the cylinders. This advantage of steam turbines has permitted Prof. Rateau to utilize the enormous quantities of steam which so far were wasted in mines and in plants equipped with powerful machines exhausting into the atmosphere and running at intermittent load. This is the case with hauling machines in mines, with machines in rolling mills, and with steam hammers. With these machines neither compounding nor condensing can be used, and the efficiency is, therefore, rather low. In any case it was very difficult to utilize the exhaust steam of these machines. They furnish an intermittent flow of steam, while a continuous jet is to be supplied to the turbine. M. Rateau has solved this problem by inventing an apparatus which he calls a "regenerative accumulator of steam." It consists of sheet iron cylinders, containing a series of cast iron plates. This plays the same role for heat as a flywheel for kinetic mechanical energy; that it stores it up, the steam being condensed at its arrival and being formed again later when the exhaust from the primary machine stops. The pressure of the exhaust steam is nearly constant, about 3 pounds. An adjustable valve, regulated by hand, permits to vary within certain limits, the pressure of the steam leaving the accumulator; in general this pressure is 2.8 to 5.2 pounds.

A very interesting application of this principle has been made at the Bruay mines at Pas de Calais. The exhaust steam of the hauling machine is fed to a turbo generator of 300-horse power. The tests showed that the machine gives 1 electric horse power at the terminal of the dynamo with a steam consumption of 39.68 pounds per hour, the steam being admitted at atmospheric pressure and the vacuum in the condenser being 24.8 inches, hence relatively bad. This figure could be reduced to 28 pounds per electric horse power hour with a better vacuum in the condenser, which is perfectly obtainable in practice.

Under these conditions the low pressure generating set would perform about three times more useful work than the hauling machine; and even with a steam consumption of 39.68 pounds per hour the work performed by the turbine set is nearly three times that of the hauling machine, for the latter consumes generally 100 pounds of steam per useful horse power hour, this very high figure for consumption being normal for a non-compound hauling machine, exhausting into the atmosphere.

These are considered to be results of great importance, and the employment of low pressure machines for the utilization of the exhaust steam of machines running at intermittent load has apparently a great industrial future.

So far turbine-driven dynamos and turbine-driven pumps have been discussed, but it may be added that the turbine is equally applicable for driving ventilators, and, in fact, at present numerous turbo-ventilators of the Rateau system are in practical use. In view of the high speed of rotation of these ventilators, it is possible to supply the speed directly to the ventilator by mounting its wheel on the shaft of the turbine itself, and thus to obtain a turbo-air compressor. This construction gives machines much less cumbersome and less expensive than piston compressors. The Sautter-Harlè works have supplied such turbo-compressors to the French Navy and the British Admiralty, and at present they are building a turbo-compressor for use in the blast furnace of the Chatillon and Commentry Works. This apparatus will give 88.3 cubic feet of air per minute at a pressure of 4 pounds.

A turbo-ventilator, when running at a speed of 20,200 r.p.m., has given a back pressure of more than 7 pounds per square inch; this pressure was obtained with a mechanical efficiency of about 60 per cent.

The figures given for the steam consumption and efficiency of the turbines show that these machines have now reached a remarkable degree of perfection and that their efficiency is superior to that of compound machines and even comparable to that of the better types of triple expansion machines. From day to day they become of greater industrial importance, being gradually substituted for piston engines on land, while for some time there has been a tendency to substitute them for the latter even on board ship.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. JOSEPH BERKLEY has been appointed Superintendent of the Springfield (Ills.) Gas Light Company. He is a competent, trustworthy man.

MR. THOMAS S. BLAIR, JR., General Manager of the newly organized Astoria (L. I.) Steel Company, informs us that the Company expects to be in active operation by October 1st.

THE Gas Machinery Company, of Cleveland, O., reports that it has been awarded the contract for a complete set of 4-foot double superheater water gas apparatus for the new plant at Patchogue, L. I. Also, that it is under contract to construct a coal gas plant for the Company at South Amboy, N. J.

THE purifying capacity of the St. Paul (Minn.) Gas Light Company is to be increased by the placing of three 32 feet by 26 feet boxes erected upon a structural steel framing. The covers are to be manipulated by means of a power travelling carriage, the boxes being operated with a system of 20-inch valves and connections. The entire work is to be placed by the Lloyd Construction Company, of Detroit, Mich.

AT the annual meeting of the Northampton (Mass.) Gas Light Company the following officers were elected: Directors, John F. Starr, L. C. Selleey, C. N. Clark, E. H. Banister and H. C. Crafts; President, C. N. Clark; Secretary and Treasurer, E. H. Banister; Superintendent, H. C. Crafts; Assistant Treasurer, R. W. Starkweather. The output of the Company for the past year exceeded that of the previous year by 20 per cent. The main system was increased by the placing of 2 miles of pipe.

CITY ATTORNEY C. A. DEAN has handed down an opinion in which he declares that the franchise under which the Sheboygan Gas Light Company is operating is valid. The local authorities contended that the franchise extension granted in 1886 was void.

IT is said that negotiations are underway by which it is proposed to consolidate the gas and electric lighting interests of Kankakee, Ills.

MR. CHAS. F. HOPPE has been appointed General Manager of the plants of the Owensboro (Ky.) Gas Light Company.

THE offices of the gas division of the Memphis (Tenn.) Consolidated Gas Company have been removed to 300 Second street.

A CORRESPONDENT in Lynn, Mass., forwards the following: "The Peoples Gas and Electric Light Company, of Stoneham, Mass., has offered the town of Reading to furnish gas at $1.25 per 1,000 cubic feet, with a discount of 5 per cent. for prompt payment, on condition that the Company be involved in no legal expense for determining the right to lay street mains in the town. The objections to accepting this apparently advantageous offer are that legal complications cannot be avoided and the fact that the gas furnished by the Peoples Company, while suited for domestic purposes, is below the candle power most effective for light. The Reading *Chronicle*, in an able presentation of both sides of the problem, incidentally says: 'It would he extreme folly, we are convinced, for the town to put in a municipal gas plant.' Wakefield has not found it so."

THE Directors of the Portland (Me.) Gas Light Company have declared a dividend of 2 per cent., payable since the 1st inst.

THE State Board of Gas and Electric Lighting Commissioners has handed down a decision, sustaining the appeal of the Haverhill (Mass.) Electric Company, and annulling the action of the Haverhill Board of Aldermen in granting a franchise to and contracting with the Haverhill Illuminating Company for furnishing electric lighting to the city. The text of the decision is as appended:

"This was an appeal by the Haverhill Electric Company from a decision of the Board of Aldermen, of Haverhill, in favor of the Haverhill Illuminating Company.

"The Haverhill Electric Company received its charter in 1888, succeeded soon after to the property and business of the Essex Electric Company, and since that time has been continuously engaged in the supply of electricity for light and power to the city of Haverhill and its residents. At the date of this appeal it was supplying the city for street lighting with arc lights of nominal 2,000-candle power, in accord with the terms of a contract which had recently expired.

"Some time before the expiration of this contract the city advertised for bids for the street lighting. In response to this invitation the Haverhill Electric Company submitted its bid of 32 cents per light per night, and certain other people, residents and non-residents of Haverhill, submitted a bid on the basis of 23 and 15-100 cents for a like service. The latter bid was accepted by the city on certain conditions and in partial fulfilment of these bidders, having become incorporated as the Haverhill Illuminating Company, applied to the Mayor and Aldermen for the general right to carry on the business of supplying electric light and power to the city. The Aldermen voted to grant this privilege, and it is from that decision that this appeal was taken.

"There was a protracted hearing before this Board in Haverhill, at which the city and both Companies were represented by counsel. The comparative ability of the two Companies to satisfactorily supply the city and citizens with electric light was considered at length. There was no serious attempt to show that the service of the existing Company in any department of its business had been poor or that its prices for commercial lights were unreasonably high. The evidence showed that its equipment was practically as efficient and economical for the class of work required of it as that which the new Company proposed to install. Its management, which has been unchanged for several years, is composed of residents of Haverhill who are, presumably, familiar with the needs of the community.

"There appeared to be nothing in either the management or the proposed equipment of the new Company which would enable it for any length of time to successfully supply electricity at lower prices or with greater public satisfaction than might be done by the existing Company. There was no offer by the new Company relative to commercial lighting either as to prices or volume of business to be undertaken, except that it would probably desire to do such business in the central and more thickly settled sections of the city. There was no claim by the new Company that it would supply either commercial lights or power at less than the prices now charged. The present Company has invested in the business about $250,000, while the new Company proposes to invest about $150,000. It is more than probable that the proposed investment would be found too small to carry on a business of equal volume with that now done, and it is, therefore, very doubtful if the new Company contemplates an equal extension of business. The new Company rested its case almost entirely upon the fact that it had offered to do street lighting at a price which would be about $6,000 per year less than the offer of the existing Company.

"There was no attempt to show that there would be any profit in the proposition of the new Company. The effect of the testimony as a whole on this point was practically an admission by the new Company that its offer would be unprofitable. Under these conditions it becomes important to consider what will be the probable results to the city as a whole from the admission of a second Company which has no superior advantages in equipment or managerial experience, which is practically silent as to plans about its commercial lighting and which seeks admission solely upon the ground of its willingness to supply street lighting at an unprofitable price.

"Experience shows that the exploitation of a new Company in a territory already occupied does not necessarily depend for its financial success upon the sale of electricity to the city and its citizens. That is by no means the only source of profit to such Company. It has been repeatedly demonstrated that the profits of a new concern do not so much depend upon its dealings with the public as upon the relations which it may be able to establish with the Company first in the field.

"If the request of the new Company is granted it may naturally be expected that for a time both city and commercial lighting will be offered by both Companies at considerably less than present rates, but such competition under the conditions in this case is sure to be expensive, even though for a time apparently economical or profitable. We may confidently expect, first losses, then profits; losses in the conduct of the business and the struggle for a control of the situation; profits in the later union or consolidation; losses for a time in the supply of electricity to be converted later into new capitalization as a perpetual and irremedial burden on the public. The temporary advantage to a portion of the public is reasonably sure to be followed by an undue burden upon the public as a whole through the larger capital demanding a return, much of it representing unnecessary duplication of properties as well as losses. The proposition of the Illuminating Company will immediately increase the investment for the supply of electricity in Haverhill from $250,000 to $400,000. Even this amount is sure to rapidly increase, probably, until it reaches a point which, in the opinion of those best qualified to judge, will be the maximum that can possibly be imposed upon the community. No offer yet made, however attractive at first sight, and none of the advantages immediately in prospect, promise adequate compensation for the increased capital charge which the consumers as a whole must necessarily bear.

"The action of the Board upon this case is not taken as a refusal to admit of competition under all circumstances nor as an indorsement or approval of the prices offered by the existing Company or of all the doings and policy of its management. It is the duty of this Company to serve all its customers at prices at the lowest reasonable point and to manage its business with such zeal, economy and enterprise as shall enable it to give the best possible service to the greatest number at the lowest cost. If it shall fail in this duty the legislature has provided the methods by which its fulfillment may be secured with an apparent purpose to avoid, if possible, the expensive and burdensome results so sure to follow such competition as is proposed in this case. The Board has ample authority, upon the petition of the Mayor or a limited number of customers, to thoroughly investigate all the Company's affairs and make such orders as the public interest may require.

"It is entirely in the Company's power to make such appeal unnecessary. Its management should of its own volition make a careful and exhaustive examination of its facilities, methods and policy so as to secure improvement and advancement as the state of the art and the business conditions will permit, and should revise, in the public interest, the figures already named in its proposition to the city.

"For the reasons stated the Board has voted to sustain the appeal and to annul the action of the Mayor and Aldermen."

AT a meeting of the Chelsea (Mass.) Gas Light Company, held persuant to call, the following officers were elected: Directors, Jas. L. Richards, Geo. W. Moses, H. C. French, Thos. Hunt and H. S. MacPherson; President, James L. Richards; Treasurer, Henry C. French; Clerk and General Manager, Herbert W. Moses. The significance of this election lies in the retirement of Col. George W. Moses from the position of Clerk and General Manager, which places he acceptably filled for virtually a quarter of a century. In fact, the Company's best record is that which was made by the Colonel. His son succeeds him, and if the youngster is up to the works of his father greater success is in line for the Chelsea Company.

THE proprietors of the Fredericton (N. B.) Gas Light Company have decided to sell their plant to the local authorities as per the tender of the latter some weeks ago.

A CORRESPONDENT in Los Angeles forwards the following under date of the 23d inst: "The Bakersfield (Cal.) Electric Light and Gas Company has been consolidated with the Power Development Company, under the name of the Power, Transit and Light Company. The new owners promise that an important cut in selling rates will be ordered before September 1st."

MR. S. R. WALKER, formerly Manager of the Bay City Company's plants at Bay City, Mich., has accepted the position of General Manager of the Glens Falls (N. Y.) Gas and Electric Company.

AT the annual meeting of the North Adams (Mass.) Gas Company the following officers were elected: Directors, C. H. Cutting, H. T. Cady, M. B. Plunkett, A. B. Daniels and F. S. Richardson; President, C. H. Cutting; Clerk and Treasurer, F. S. Richardson.

MR. A. M. WHITNEY, the astute and irreproachable Secretary of the Spencer (Mass.) Gas Company, says that Superintendent Clark is an adept in the business of placing gas ranges. Undoubtedly that is so; but if Secretary Whitney were only to canvass the town himself the "Super." would certainly have too much to do making the necessary connections.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
EDITORS.

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OHIO GAS LIGHT ASSOCIATION.

NOTIFICATION RESPECTING ADVERTISING.

Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:

New York—American News Co., 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, AUGUST 3, 1903.

The Market for Gas Securities.

The gamblers in Wall street seem to have reached that stage which betokens lethargy; for, after their athletics of six weeks past, they know that nature will not be denied. So most of the high-ordered financiers have "gone away back" to sleep. Possibly the sleepiest of the lot is Mr. James R. Keene's near relative; but in a like physical condition is another celebrated gentleman, not distinctly connected with the gas business, whose shrill cry of *peccavi* has elicited Hiawatha-like orchestration from those who well remember his mellifluous notes of 1898. On the theory that every dog has his day, not forgetting that the nights are for the cats, investors in gas securities have reason for thankfulness that their specialties withstood the onslaught of the bear leaders so well.

While values have been nominally improved the quotations are still at figures which should induce prudent men to buy. To make it short, the battle of the giants for 1903 is over. Buy gas stocks now and no mistake can be made. The Consolidated Company, of New York, has declared its regular quarterly dividend of 2 per cent., making it payable September 15th. The proposed scheme for the reorganization of Bay State gas, of Delaware, will never be operative. In our belief not 6 per cent. of the outstanding stock will assent.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

AUGUST 3.

☞All communications will receive particular attention.

☞The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	185¼	187
Central Union, Bonds, 5's.	3,000,000	1,000	109	111
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	118	120
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	299	320
Municipal Bonds	750,000	..	..	
New Amsterdam Gas Co. ..				
Bonds, 5's	11,000,000	1,000	107⅛	108
Northern Union, Bonds, 5's.	1,250,000	1,000	106	107
New York and East River				
Bonds 1st 5's	3,500,000	1,000	110	113
" 1st Con. 5's	1,500,000		109	111
Standard	5,000,000	100	135	140
Preferred	5,000,000	100	155	170
Bonds, 1st Mortgage, 5's	1,500,000	1,000	116	117
Yonkers	299,650	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	192	200
" " Bonds (5's)	15 000,000	1,000	119	119⅛
Bay State	50,000,000	50	¼	⅜
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	28	30
" 1st Mtg. 5's	500,000	1,000	93	96
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	3¾	4¼
" " Bonds, 5's	5,250,000	1,000	73	76
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Central, San Francisco	1,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas & Elec. Co.	29,500,000	100	97	97⅛
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	101	101⅛
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	88¼	89⅛
Preferred	3,026,500	100	107⅛	109
Consumers' Jersey City Bonds	600,000	1,000	100	102
Consumers, Toronto	1,700,000	50	218	225
Consolidated, Baltimore	11,000,000	100	66⅛	68
Mortgage, 6's	3,600,000	..	..	115
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	15	17
" Con. Mtg. 5's	880,000	1,000	85	87
Consolidated G. & E. Co.'s. Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,825,500	50	87	95
" Prior Lien 5's	5,603,000	1,000	99⅛	100
Detroit Gas Co., 5's	361,000	1,000	77	79
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	39	40
Fort Wayne	2,000,000	..	..	..
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	245	265
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	56	60
" Bonds, 6's	2,650,000	..	104¾	106
Jackson Gas Co	250,000	50	73	75
" 1st Mtg. 5's	200,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	79	90
Preferred	2,500,000	100	85	..
Bonds	10,000,000	1,000	109½	110
Lafayette Gas Co., Ind.	1,000,000	100	.	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	130	140
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	107½	108½
" 6 per cent. scrip, due 1910	100,000	25	85	87
Montreal, Canada	2,000,000	100	218	184¾
Nashville Gas Lt. Co.	1,000,000	100	110	..
Newark, N. J., Con. Gas Co	6,000,000	..	56	58
Bonds, 6's	4,600,000	..	105	105¾
New Haven	1,000,000	25	300	325
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	.
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	94¼	95
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
" 2d "	2,500,000	1,000	104	..
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87¼	90
San Francisco, Cal.	0,000,000	100	51½	52
St. Joseph Gas Co.				
" 1st Mtg. 5's	751,000	1,000	95	96¼
St. Paul Gas Light Co	1,500,000	100	45	47
1st Mortgage 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	92	93
Syracuse, N. Y.	1,975,000	100	46	48
Bonds	2,047,000	1,000	98⅛	99½
Washington, D. C	2,600,000	20	296½	300
First mortgage 6's	600,000	..	..	..
Western, Milwaukee.				
Bonds, 5's	4,000,000	..	109⅛	110
Wilmington, Del.	600,000	50	232	

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All bids should be addressed or delivered to the undersigned City Clerk, at Superior, Wis. JOHN A. HOBEN.
1469-3

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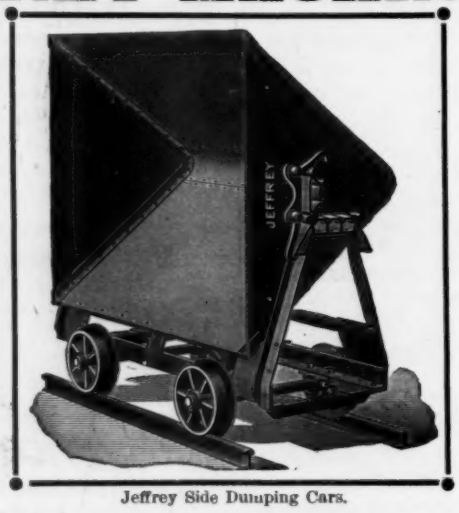

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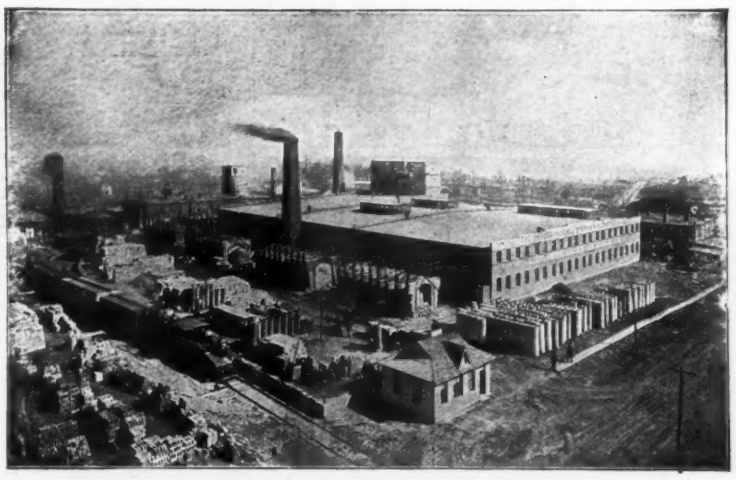

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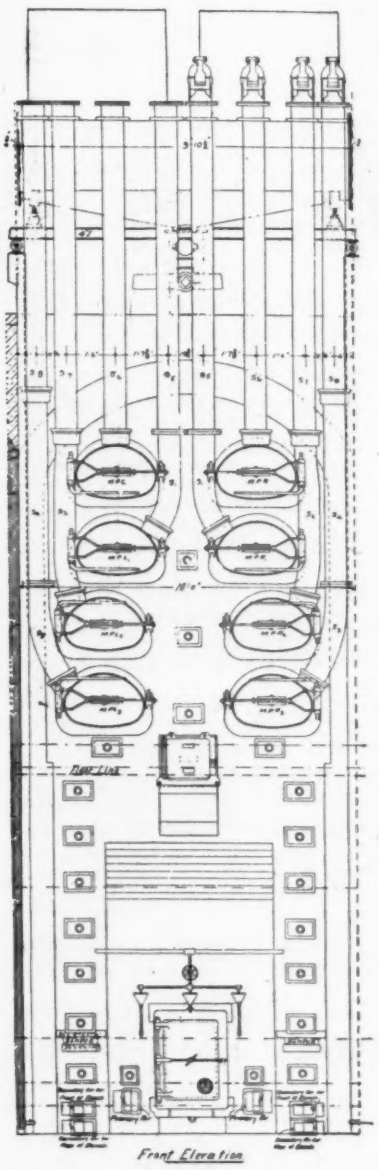

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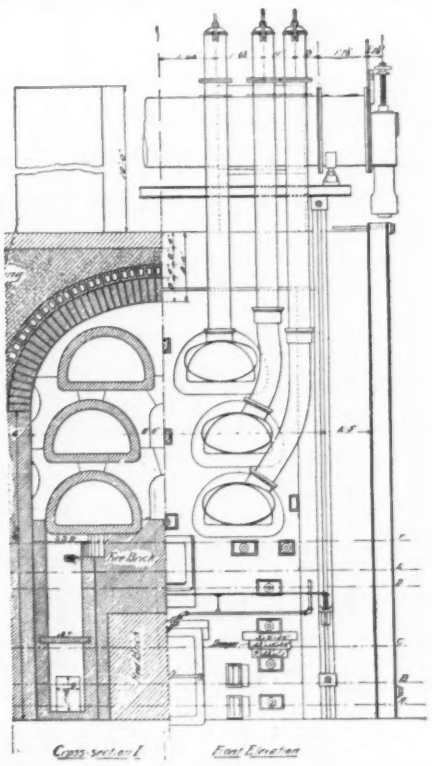

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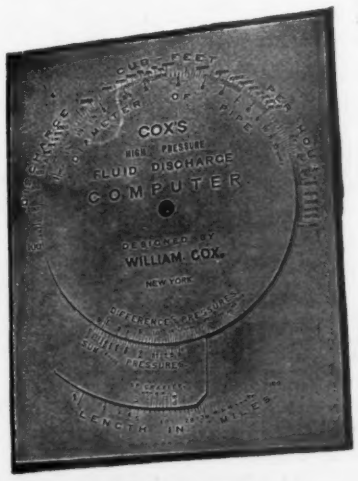

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Where d = diameter of pipe in inches,
p_1 = absolute initial pressure in pounds per square inch,
p_2 = absolute terminal pressure in pounds per square inch,
L = length of pipe in miles,
w = specific gravity of the fluid when air = 1.

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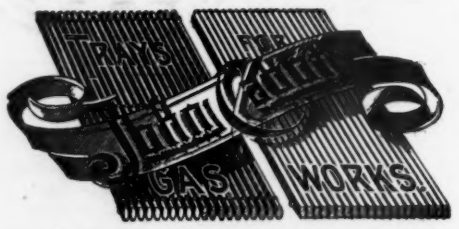

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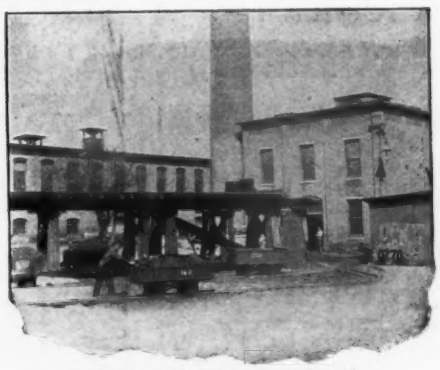

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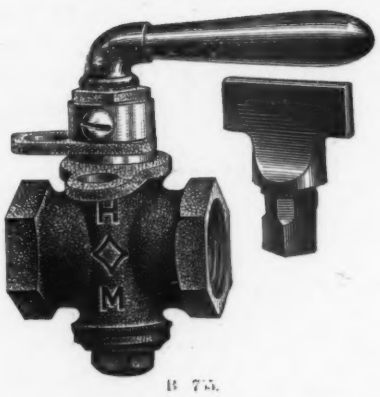

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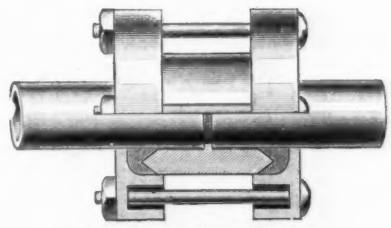

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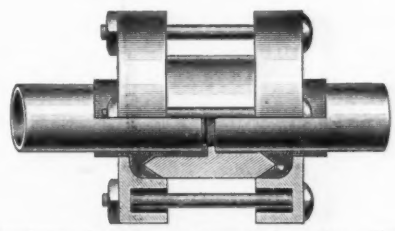

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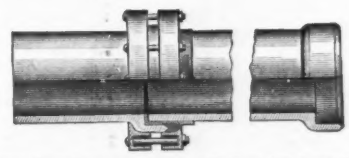
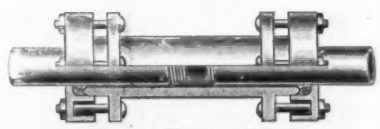
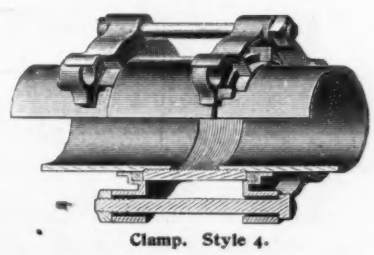


Insulating Coupling for Dresser Bell and Spigot Cast Iron Pipe. Style 6.



Regular Sleeve. Style 2.



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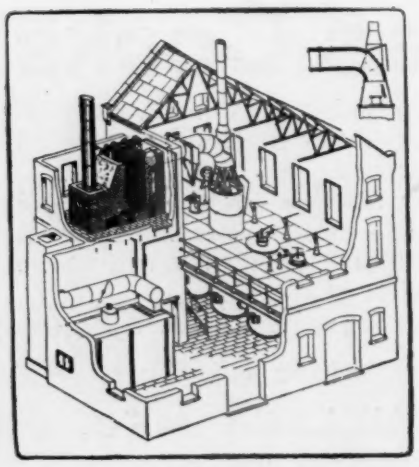

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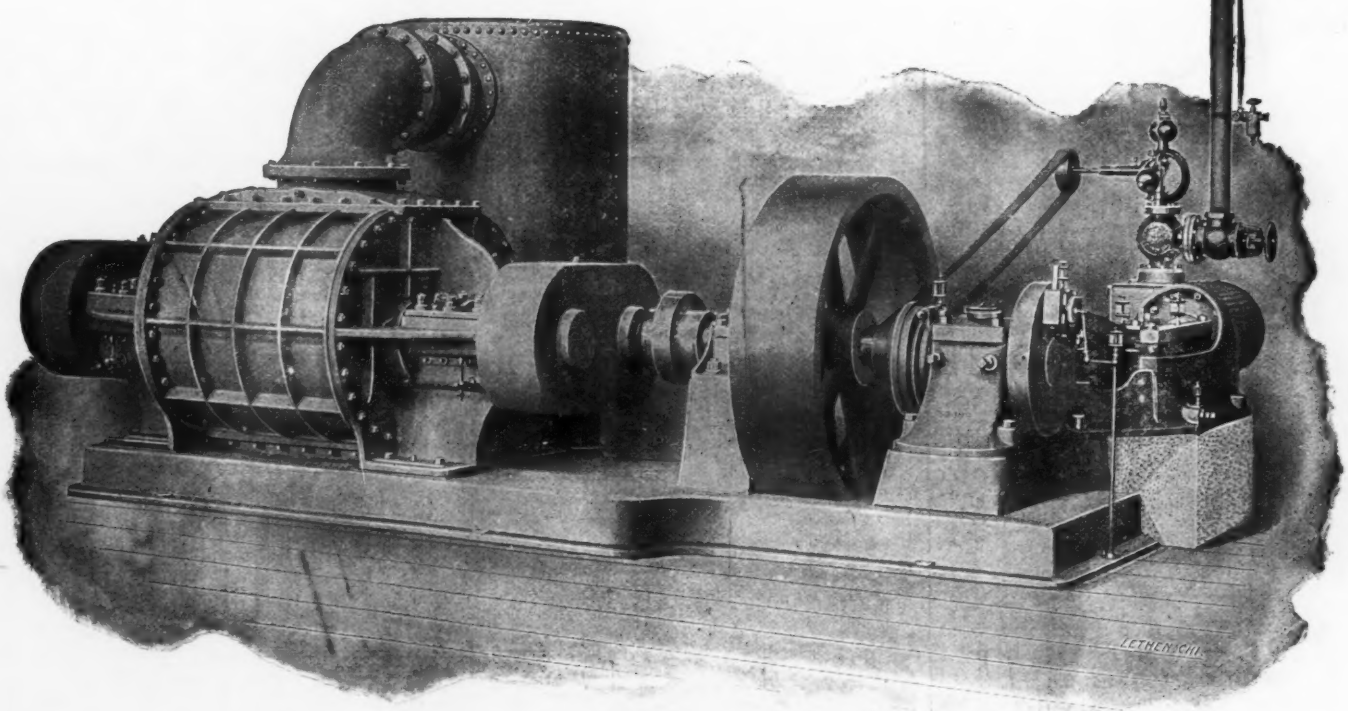

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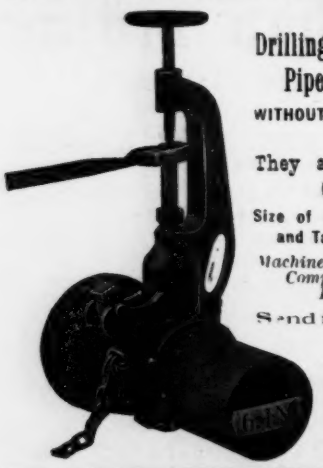

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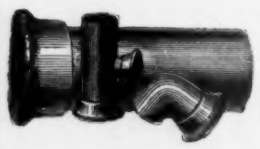

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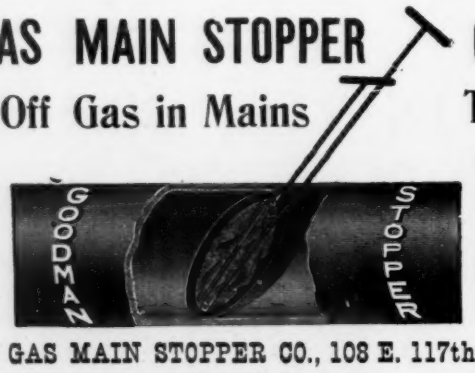

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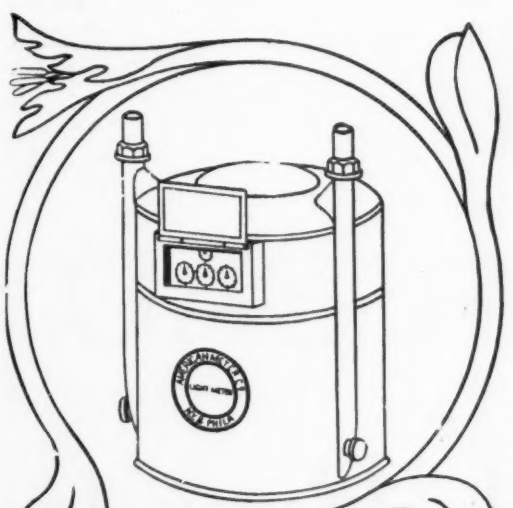
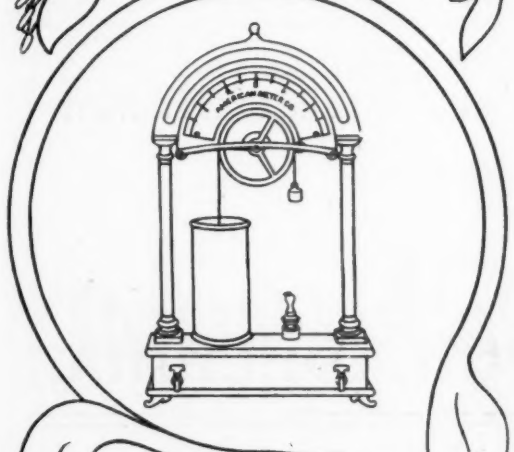
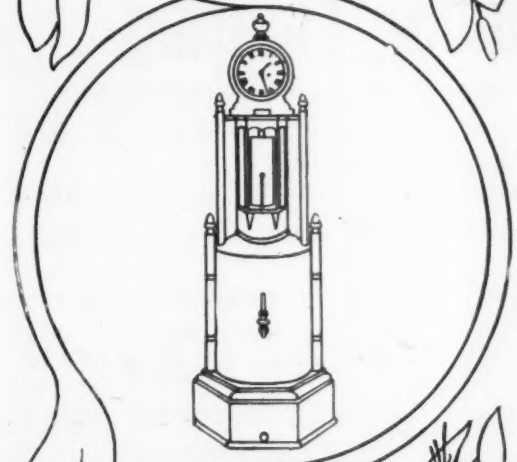
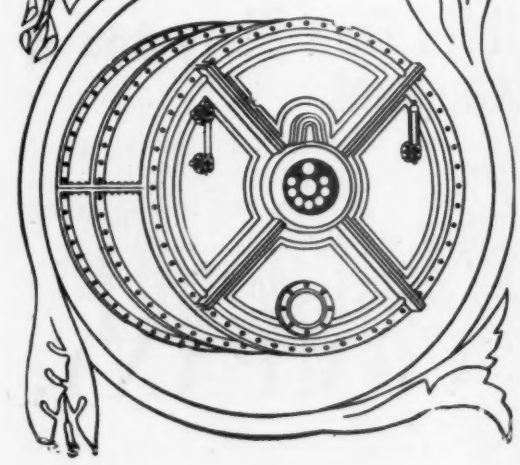








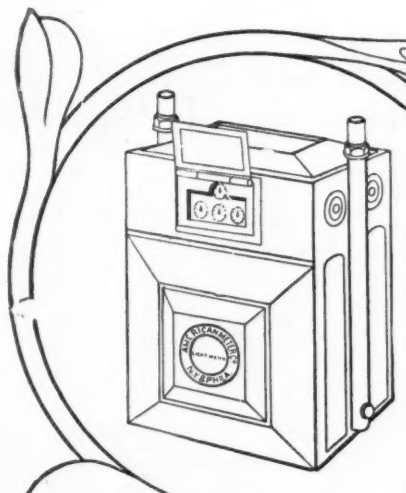
PUBLIC LIGHTING TABLE.

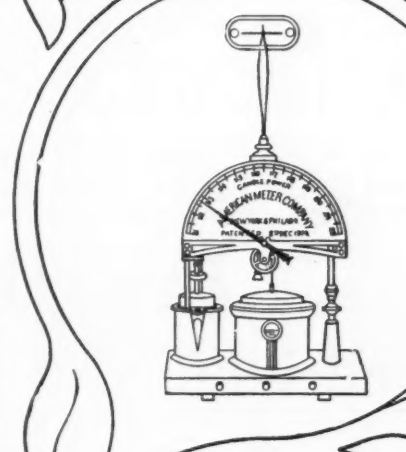
AUGUST, 1903.

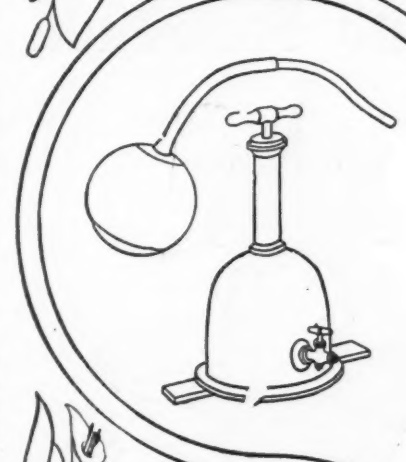
Day of Week.	Table No. 1. Following the Moon. Date.	Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Sat.	1	11.20 PM	3.50 AM	7.10	3.30
Sun.	2	12.10 AM	4.00	7.10	3.30
Mon.	3	1.00	4.00	7.10	3.30
Tue.	4	1.40	4.00	7.10	3.30
Wed.	5	2.30	4.00	7.10	3.30
Thu.	6	No L.	No L.	7.10	3.45
Fri.	7	No L. FM	No L.	7.10	3.45
Sat.	8	No L.	No L.	7.10	3.45
Sun.	9	7.30 PM	8.40 PM	7.10	3.45
Mon.	10	7.30	9.10	7.10	3.45
Tue.	11	7.30	9.40	7.10	3.45
Wed.	12	7.30	10.10	7.10	3.45
Thu.	13	7.30	10.40	6.55	4.00
Fri.	14	7.30	11.20	6.55	4.00
Sat.	15	7.30 LQ	11.50	6.55	4.00
Sun.	16	7.20	12.40 AM	6.55	4.00
Mon.	17	7.20	1.30	6.55	4.00
Tue.	18	7.20	2.30	6.55	4.00
Wed.	19	7.20	4.10	6.55	4.00
Thu.	20	7.20	4.10	6.45	4.10
Fri.	21	7.20	4.10	6.45	4.10
Sat.	22	7.20 NM	4.10	6.45	4.10
Sun.	23	7.10	4.20	6.45	4.10
Mon.	24	7.10	4.20	6.45	4.10
Tue.	25	7.10	4.20	6.45	4.10
Wed.	26	7.10	4.20	6.45	4.10
Thu.	27	8 40	4.20	6.30	4.20
Fri.	28	9.20	4.20	6.30	4.20
Sat.	29	10.00 FQ	4.20	6.30	4.20
Sun.	30	10.50	4.30	6.30	4.20
Mon.	31	11.40	4.30	6.30	4.20

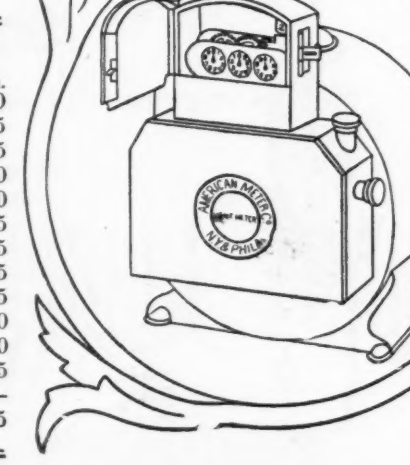
TOTAL HOURS LIGHTING DURING 1903.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	245.00	January	423.20
February	192.00	February	355.25
March	201.00	March	355.35
April	167.20	April	298.50
May	152.00	May	264.50
June	131.00	June	234.25
July	140.40	July	243.45
August	156.20	August	280.25
September	171.20	September	321.15
October	198.20	October	374.30
November	216.30	November	401.40
December	232.10	December	433.45
Total, yr.	2203.40	Total, yr.	3987.45









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TOTAL DAILY CAPACITY, ... 55,150,000 cubic feet.
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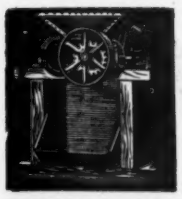

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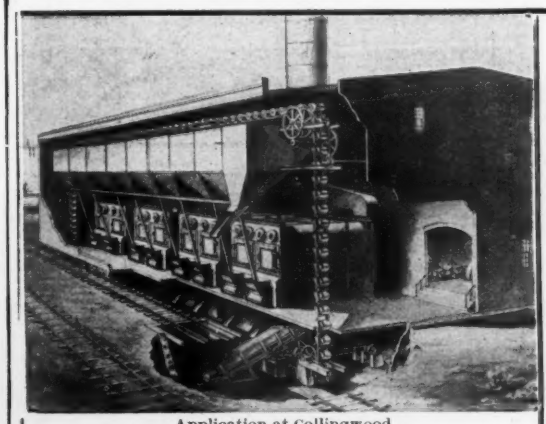

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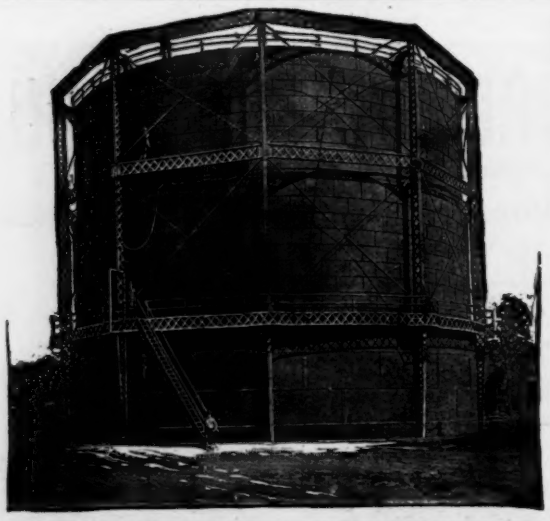

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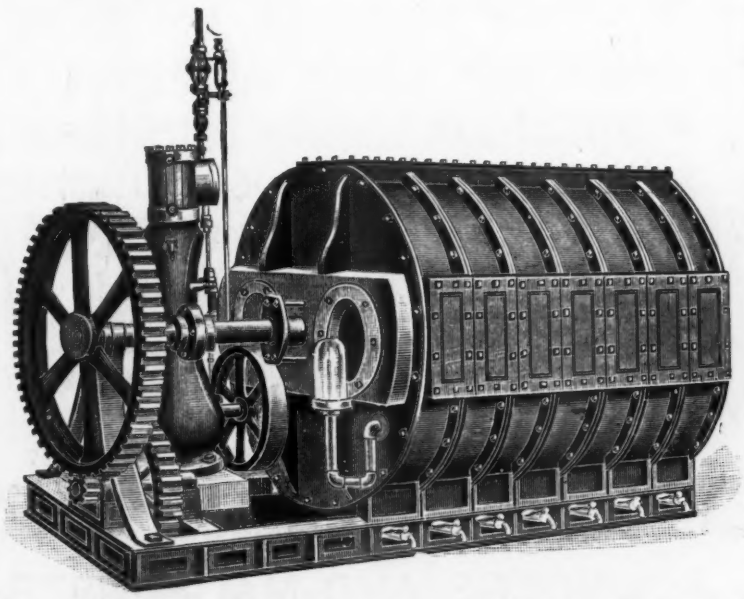

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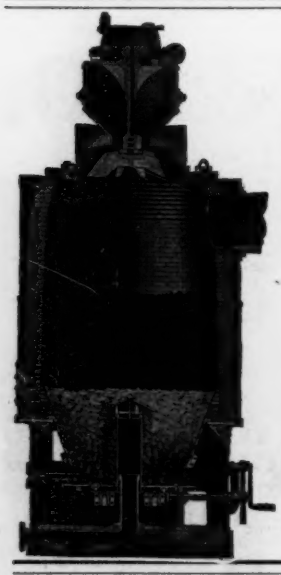

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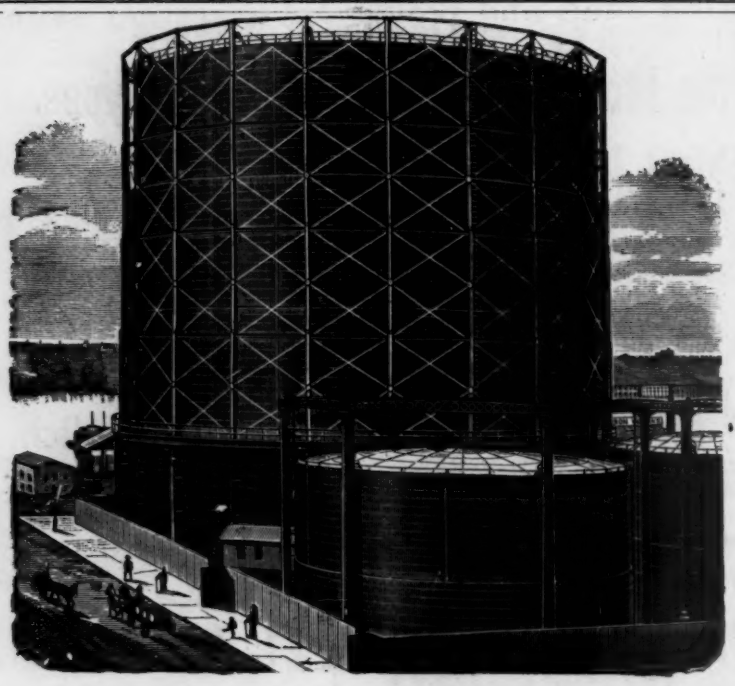

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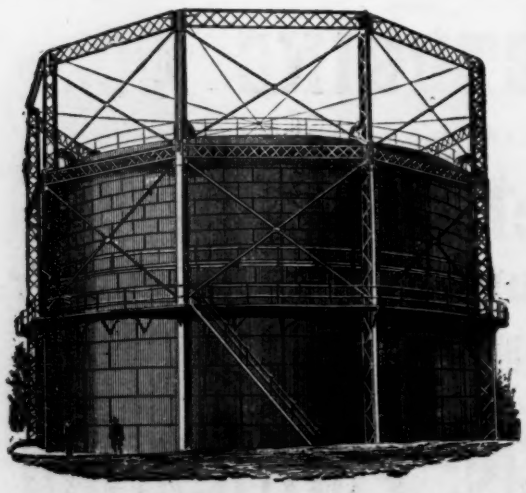

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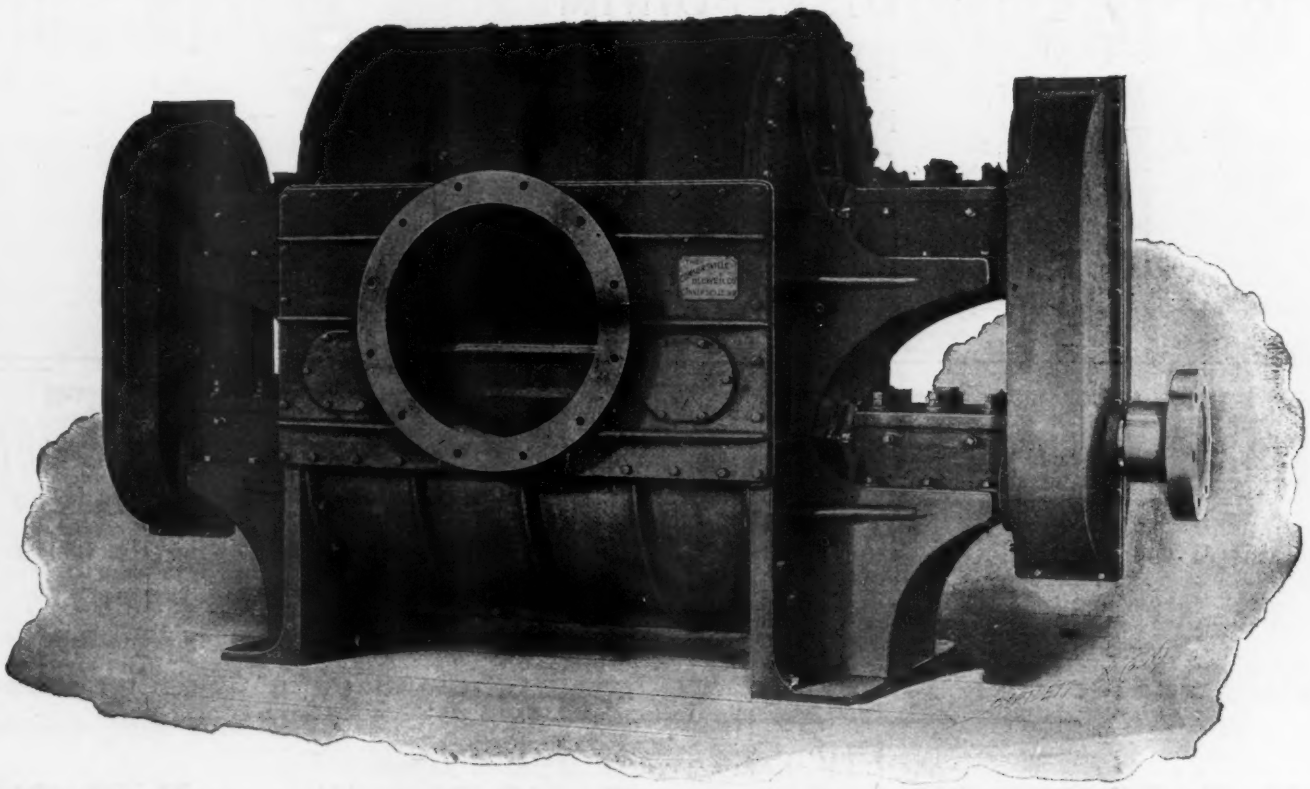

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